THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 23. Thursday, May 5, 1921. No. 246.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

The Foundry Trade Journal,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI, LONDON, W.C.2.

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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NOTES AND COMMENTS.

Fuel Economy.

In the "Fuel Economy Review," published by the Federation of British Industries, Sir Robert Hadfield aptly summarises the national importance of this question as follows:—

"An elementary consideration of the economic position of the nation reveals the fact that we can only maintain our existence by an exchange of manufactured articles, coal, and personal services, including shipping and finance, against the foodstuffs and raw materials of other countries. This interdependence of nations is of a very complex nature, but if examined in detail it will be found that the position of the United Kingdom is mainly determined by the price of coal.

"In the direct supply of this, as of other commodities, there is a definite price level above which demand ceases. Again, in the case of manufactured articles the cumulative effect of fuel costs in the various stages of production is one of the decisive factors in trade competition with other countries. Therefore, unless the price of coal is such that our export trade in this commodity and in manufactured goods can be maintained and developed, the feeding of the nation, and the provision of raw materials for its mills and factories, will be most seriously hampered.

"Industrial development will inevitably be greatest in those countries in which energy is most economically produced and efficiently used. It has now been established by various technical authorities in England, America, and Germany that, on an average, 25 per cent. of the total coal used is non-productive, or that at least 30 per cent. more energy should be obtained from the coal the world is using. Even on our national consumption of 180,000,000 tons the saving to be effected at the present price of coal would be very great, probably about £50,000,000 per annum."

In the iron foundry, as in all metallurgical industries, there is ample scope for much economy. As so many foundries are of great age they still prosecute the same wasteful systems of their ancestors. In the cupola and other melting plant, mould and core drying stoves, annealing ovens, and shop heating, enormous waste is constantly taking place. This is borne out by the fact that the foundry foreman is singled out for tuition by the Office Central de Chauffe Rationale, a French Government-subsidised company, whose principal activities include: (*a*) Factory visits by specialists for the purpose of advising on the improvement of existing installations and of new plant; (*b*) a training school for maintenance managers, overlookers, foundry foremen, charge hands, etc.; (*c*) a study centre for the collection of documents and the conducting of researches.

The Sales Engineer.

The desire to effect improvement is strong in the minds of most foundrymen, but lack of funds and absence of faith in the ability of new plants to give as good results as their present installations are retarding improvements. Before the war cases came under our notice where German sellers of metallurgical plant awaited payment until the machine installed had effected sufficient economies to pay for it. Owing to the still high Bank rate it is difficult for the sellers of plant to accord extended credit, but ways and means should be sought to give confidence to the buyer that economies will result. A real improvement has taken place during the last decade amongst the sellers of metallurgical plant and products by the replacing of the commercial traveller by the sales engineer. The conditions existing today are such that in every works a certain number of callers are *personæ gratis*, whereas many others never get beyond the office boy or commissionaire; in other words, much business is still placed through friendship. If a foreigner presents himself at the average British works the caller is fairly sure of an interview, as perhaps the buyer subconsciously thinks he will be able to learn something. Granted the hypothesis that both buyer and salesman are competent, technically-trained men, every interview would be beneficial. But until something like these conditions are realised in commerce much time and money will continue to be lost.

Welsh Engineers' and Founders' Association.

One of the developments of modern times is the formation of trade associations, and the foundry is no exception to the rule. The Welsh Engineers' and Founders' Association, a strong organisation of this nature which exists in South Wales, has realised the advantages to be obtained from publicity, and has appointed THE FOUNDRY TRADE JOURNAL as their official organ. No doubt this will be followed by other similar organisations.

A Design for a Large Jobbing Foundry.

By H. Lewin (Winner of the 2nd Prize in the Foundrymen's Competition).

The question of main offices where quotations would be prepared and the chief correspondence handled is left out, and that a suitable power station is installed or that an equivalent electricity supply is available is assumed.

The general layout would be as shown in Fig. I., and would consist of the following departments and methods of working.

It is necessary that a foundry of this description should be in close contact with a main line of a railway, not only for the supply of raw materials, but also for the immediate removal of finished castings to customers' requirements, and of refuse.

Whilst the general arrangement explains itself to a certain extent, a further description will be helpful.

First, a consignment of timber suitable for making patterns is sent in. This is taken down line marked A A, to be unloaded and stored in the timber shed marked B. A record should be kept of this timber, and it should be thoroughly examined when received and reported on to the founary manager. Immediate action in the shape of complaints to the senders can then be taken if necessary. The empty wagon can then be shunted on to the next set of rails and used for loading fettled castings from the fettling shed, shown at E; or it may be shunted still further to the next set of rails and do duty for the foundry, either by removing boxparts or other moulding tackle or discarded sand and refuse, or sent out of the works as an empty.

Pattern Store.—This is an airy building on the ground floor at C, and the pattern shop is over it (on the second floor). The pattern store should be systematically divided into suitable compartments, lettered alphabetically, with sufficient walking room between each. A reliable man should be kept solely for the purpose of checking all patterns going into the foundry, and also receiving them into stock. There are several approved methods of doing this work, and each foreman pattern maker will no doubt work the one he favours most.

The arrangement is such that the fettling shed crane can do the unloading of timber and stocking same in the timber shed at B, this being under the same roof as the fettling shed.

Pattern Shop.—This should be a well-lighted shop, having plenty of window space. On the drawing this is 400 ft. long × 50 ft. wide.

The necessary machinery should include two bandsaws, two planers, a circular saw, a disc sandpapering machine, a mortising machine, and a couple of lathes. A grinding machine of the Universal type is also necessary for grinding the planing machine blades. This machine also has various emery wheels for gouge chisels, flat chisels and plane irons, also a revolving oilstone.

The arrangement of benches would be along each wall-side, so as to obtain the maximum benefit from the windows. These benches to extend as far as the machinery.

Other benches would be fixed across the shop at right angles to the walls leaving sufficient space between the ends of them and the wall benches for two people to pass each other easily.

This shop would require a head foreman, and an assistant, who would have to do most of the work outside the pattern shop, and be in touch with all jobs in hand in the foundry. This shop should be heated by hot air by some arrangement outside the building and driven into the shop by fans.

The foundry itself would be built in two separate shops as shown. The one marked 600 tons foundry is 400 ft. long, and in two bays, each 50 ft. span at crane tracks, and 25 ft. lift, from which there should be obtained 600 tons of castings per month, from, say, 10 tons to 25 tons in weight each.

Sand and manure bunkers are shown at D, so that this material could be easily unloaded from trucks by tipping the truck. These bunkers should be arranged underneath five sets of loam mills, and each bunker would have a capacity of 50 tons. It is very necessary to provide for these stocks, as constant supplies are not always obtainable. For instance, during a spell of wet weather, it is impossible to work the sand quarries. A truck of sand would be put into position in front of the bunker and would be on a platform in a revolving cage. The truck would be fixed in position, and the cage turned through an angle, say, of 135 deg. The contents of the wagon would then fall into a shute which would lead the sand into the underground bunkers. The sand would then be conveyed by elevator to the mills for grinding on the floor above. This also applies to manure.

Loam Mills.—Each one of these would be a separate unit; that is, they would be arranged to have them all bottom driven by one motor and have a clutch for each pan.

The pan itself would be a fixture; the rollers would travel round the inside of the pan. Water would be connected to each pan for loam-grinding when required.

In the main shop, immediately in front of the loam mills, would be arranged the loam moulding, which would occupy about 100 ft. Across the shop in the next bay the coremakers would be installed. All cores would be dried in stoves, of which there are nine each, 15 ft. high, built outside the shop. They would be fitted with lifting-type doors, constructed of suitable angles and tees, etc., and sheet iron inside and outside packed with asbestos wool or some other non-conductor of heat. These stoves would be heated with hot air by an external furnace and a fan to force the air through the stoves when in operation. An endeavour would be made to use the waste heat coming from the cupola for heating the stoves. The stoves would be constructed so that any one could be shut off without interfering with the working of the others. Each stove would have three sets of rails running into it at 4 ft. 9-in. gauge, with approximately 2 ft. 6-in. space between each set. The bogies, on which the cores would stand, would all be made alike, and could be fastened together if necessary to carry one large core, or the top part of a large mould. The rails would be slightly declined into the stove. The bogies would have ball bearings and a couple of men would push them easily into the stove for drying cores. A pulley could be fixed in the floor with a wire rope or a chain round it. One end of this rope or chain would be attached to the bogie and the other end to the crane hook. The crane would operate its hoist motion, and so draw the bogie out of the stove again when ready.

The remainder of the shop would be used for moulding purposes.

Further, to assist in drying moulds in the shop there would be several portable furnaces. Each one would be connected with a small motor-driven blowing fan.

The furnace would be fixed over a closed mould, and stand directly over the pouring hole. A suitable fuel would be burnt in this stove, air from the fan would be driven through it, and the hot air thus developed would be driven through the mould.

Each bay would be served by two 40-ton overhead electric cranes, each having a 5-ton auxiliary hoist. Also one 10-ton travelling crane in each bay. The similar powered cranes, all of 25 ft. lift, should be of one make and interchangeable in case of any breakdown.

Inside the shop on same side as the loam mills there would be three 3-ton electrically-operated jib wall cranes of 15 ft. radius. On this side there would be, say, three openings at intervals, of such dimensions that large box parts up to three tons weight can be taken through by means of the wall cranes and deposited on truck or *vice versâ*.

Heavier box-parts would be brought from stock ground (or newly made, as the case might be) by yard crane and deposited under the fettling shed. They would then be moved by the fettling shed overhead crane, and put within reach of the foundry overhead crane, which would take them to the position where they were to be used. Also

PATTERN STORE ON GROUND FLOOR.

by means of hoppers all refuse could be removed in this way.

These wall cranes would also be useful in taking hoppers of sand and loam to the various jobs in the shop within reach, and by taking to near other jobs would save the overhead cranes considerable running about.

This shop would be fed by three 10-ton per hr. cupolas to work two each day, both blown by a suitable Roots blower or equal. A stand-by set in case of breakdown would be installed.

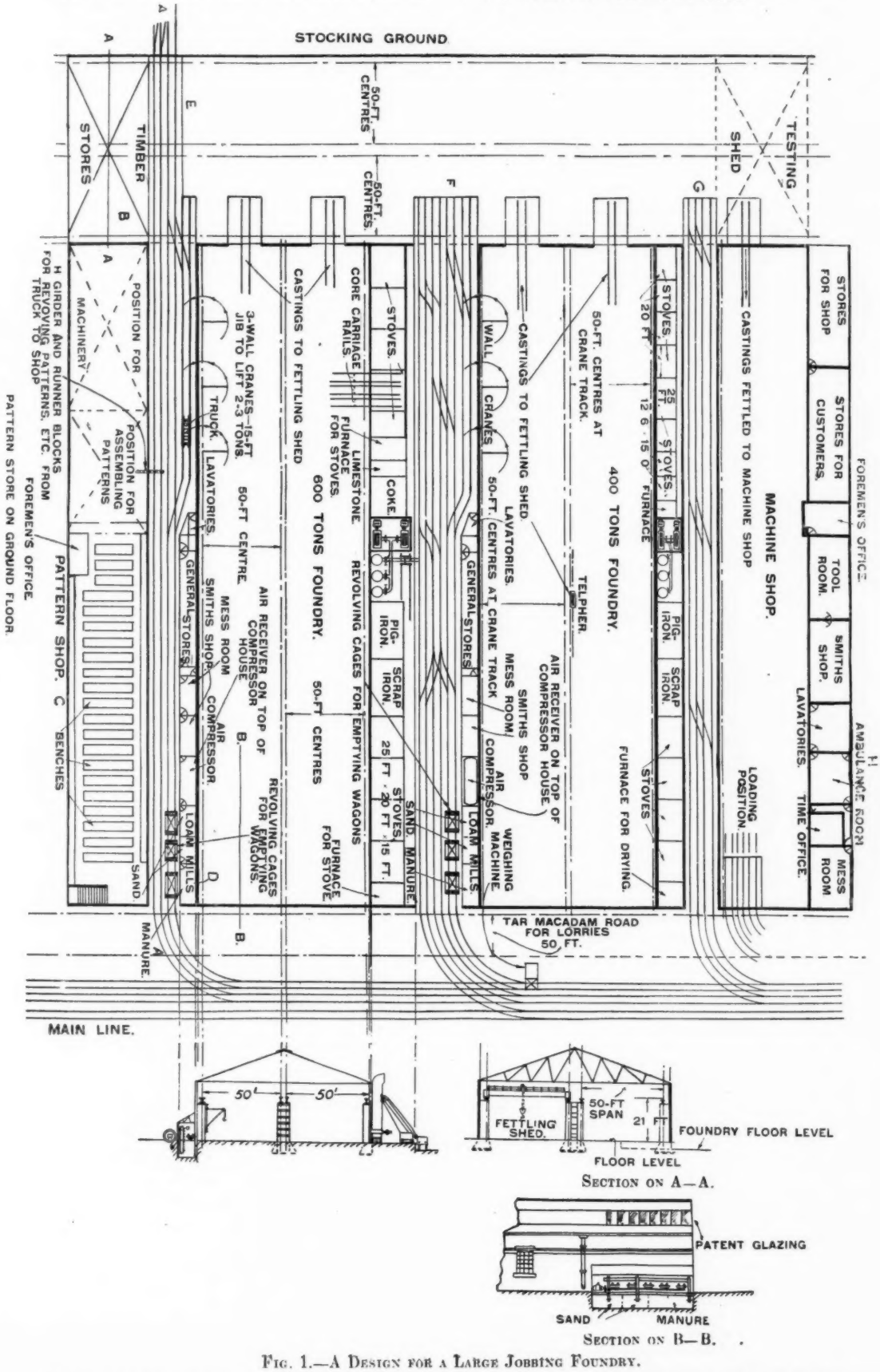

FIG. 1.—A DESIGN FOR A LARGE JOBBING FOUNDRY.

The pig-iron would be brought by rail to a position in front of the cupola. Instead of the ordinary hoist and a man on top of the platform, the cupola

would be fed with a motor-driven hoist on the endless chain system, with sufficient hoppers on it to carry a 1-ton charge complete, including pig-iron or scrap, coke, limestone, etc.

This hoist would be arranged on rails so as to move it from one cupola to the other. Coke, etc., would be wheeled in barrows from their respective trucks to the hoisting arrangement.

Sufficient stock of iron and coke would be arranged close to the cupola, in case supplies were held up, to carry over at least three days. Of course, all this stocking means double handling and increased cost, and should be obviated as much as possible. All material must be weighed before going up the hoist.

At the position next to air compressor, there would be the foundry stores. This would be a building with steel frame work and covered with corrugated sheeting, where core ropes, blacking, plumbago, coal-dust, core-gum, studs, chaplets, sprigs, shovels, riddles, etc., would be stored. These would be in charge of a competent storekeeper, who would only release them in exchange for a written order signed by the shop foreman.

A medium-sized compressor and a large receiver fixed over it would be installed next to the loam mill buildings. This would be used for blowing loose sand out of moulds when finishing them off and for portable oil-flame drying lamps for skin-drying moulds in the floor.

Jarring Machines.—The installation of jarring machines in a large jobbing foundry is rather unsatisfactory, as so many patterns are bedded in the floor that there is little room for such a machine to show good results. Again, in this larger type of casting very few are required off each pattern at one time, and it would seldom pay to make special tackle.

There are, however, odd jobs where a moulding machine could be used satisfactorily, and one having a capacity of approximately 7 tons would be installed. Possibly it would not be in use the whole of the time unless special attention was given in accepting those orders which included castings which could be made on such a machine.

A roll-over pattern-drawing moulding machine would be installed in this department. Both these types would be worked by compressed air of 100 lbs. per sq. in., and would necessitate a fairly large receiver.

Metal.—A set of lines are shown in the drawing suitable for the ladle carriage to run from each cupola into the far bay, where the overhead crane could then reach it and take the ladle of metal to wherever it was required.

After castings were stripped from the mould the overhead crane would take them down the shop to deposit them on a bogie, which could run into the fettling shed.

Fettling Shed.—This would be a steel framed building approximately 100 ft. x 400 ft. long, and designed to carry equivalent loads to the maximum made in the foundry. This would necessitate two 40-ton cranes similarly constructed to the foundry cranes, each working in separate bays of approximately 50 ft. span by 21 ft. lift. All castings would be weighed after fettling whilst being loaded into truck for despatching to the customer. All incoming or outgoing wagons would be weighed on the weighing machine shown fixed on the main line, and would thus check the fettling shed weights.

The large foundry would be served as follows:—Between the pattern shop and the foundry there would be two sets of lines as shown. Timber, patterns, etc., would be taken along this line to their respective stores. Patterns could be unloaded by means of the fettling shed crane and dropped on to a bogie to run into reach of pattern shop, or a suitable crane arrangement could be fixed to lift direct from wagon into the pattern shop.

The line running along the foundry side would pass through the fettling shed and on to the stocking ground, where the box parts and tackle would be kept when not in use. This line also could be used for taking rubbish from the fettled castings, and also from the foundry, as explained earlier. Also it would be a useful exit for fettled castings which had no machining to be done on them.

On the cupola side of the shop materials would be brought along to the cupolas and unloaded. The empties could then be sent forward to be loaded with castings ready for despatch, or else switched on to the line next to it and sent out as empties. Or, again, these empties could be passed over to the next line, and so do any duty required in the next foundry department.

It would also be necessary to have a 10-ton yard shunting crane for handling the box parts and tackle on stock yard.

The next building would be a foundry for making castings up to 6 tons in weight, chiefly in one bay. The shop would be laid generally as the larger casting foundry, the small work being done in the same bay as the stoves.

There would be three overhead cranes in one bay of 10-ton capacity, and one of 10-ton and two of 5-ton capacity in the stove bay. This shop would be provided with three or four jarring machines, and be prepared for small repeat orders. The jarring machines would be of the compressed air type and both plain up, to two to three tons, and small roll-over machines, up to, say, 10 cwt.

There would be three cupolas each to melt 6 tons per hour, and driven similarly to the larger cupolas. It is preferable that these two shops should be entirely self-contained, but they could probably help one another in case of emergency.

Fairly high, up, on the centre crane-track support, there would be a telpher arrangement, which could be used for many things, amongst others being the delivery of sand to the various jobs and the taking of castings to the fettling shed. This telpher arrangement to be fixed on the stove side of the centre columns. Castings could also be taken out of this bay by crane as well as by the telpher.

Arriving in the fettling shop, castings would be sorted out and suitable ones would be put into tumblers, of which three are shown.

All castings as fettled could be loaded either at E, F, or G. Castings which had to be tested hydraulically (by means of a pump) would be delivered into the testing shed.

Castings to be machined would be passed on to the machine and fitting shop. This would be a steel framed building of suitable design, filled in between with brickwork properly built so as to bind the stanchions in a workmanlike manner. The end of this machine shop would have a large doorway, where a bogie could be run into it from the fettling shed end to deliver castings.

This machine shop would be equipped with machine tools to do any machining required on castings made to customers' orders. It would also have two 30-ton cranes overhead and two of five tons capacity. The dimensions of the machine shop would be approximately 400 ft. by 50 ft.

At the end opposite to the fettling shed there would be arranged three bays, each to hold two trucks for the despatching of finished work. These could also be used for bringing in any fresh machinery, or the receiving of parts ordered from other firms which would be required to assemble with a customer's order.

The "heavy" machines would be arranged at the fettling shop end and the lighter ones farther down the shop. Generally the machines would be fixed along each wall side, and would include a planing machine of, say, 20 ft. stroke minimum, a large boring mill with an 18 ft. dia. faceplate, and Nos. 1, 2 and 3 Pearn Richard facing and boring machines, shaping machine (double headed), slotter, keyseater, and internal grinding attachments.

Any jobs to be assembled would be worked on between the wagon positions and up to 120 ft. into the shop, this part having the fitters' benches along each wall. This department would also have to provide sufficient skilled labour to do all necessary plant repairs, and keep all spare parts for plant in stores alongside, wherever possible, and so facilitate a speedy renewal of operations in any department.

Outside the machine shop would be a lean-to roofed building comprising (as shown) shop stores and tool room, smiths' shop, lavatories for men and foremen, stores for parts prepared in advance of assembly, foremen's office, time office, and mess room.

It is also very necessary to have an ambulance room which is easily accessible. This is shown at H on the accompanying figure, and is within reach of all departments. It should be able to give first aid to any case, and be in direct telephonic communication with the doctor.

Book Reviews.

FOUNDRY WORK. By Ben Shaw and Jas. Edgar. Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 2s. 6d. net.

This book is uniform with "Pattern-making," which we recently reviewed, and forms one of a series of technical primers. The authors are well-known to our readers, being regular contributors. As an elementary text-book, it should be much sought after by students, apprentices, and engineers wishing to obtain a working knowledge of foundry work.

PATTERN-MAKING. By Joseph A. Shelley. Machinery Publishing Company, Limited, 51, Chancery Lane, London, W.C.2. Price, 16s. net. The author in this book has dealt in an exhaustive manner with the general principles underlying pattern-making, and has, as far as possible, kept away from specific cases. There are sixteen chapters, which take the subject right from the tools used to finishing pattern work. The illustrations, which are particularly clear, are numerous and well chosen. Though the book is written by an American, the principles shown coincide with British practice. A chapter on the lay-out of the pattern-shop might have been usefully included. Another subject coming within the scope of pattern-making, which might have been dealt with at greater length, is that of pattern plates. As a treatise for technical schools, or as a guide to draughtsmen, this book should find a good field.

A Comparison Between American and British Malleable Iron Practice.

Mr. H. A. Schwartz, writing in the current issue of "The Foundry," points out with reference to Mr. F. H. Hurren's lecture on "Experiments in Malleable Iron" which appeared in our issue of February 10 that Mr. Hurren's conclusions are required to be interpreted for the American reader owing to the difference between European and American malleable iron practice.

The English writer, Hatfield, says:—

"The materials used in Britain in the production of malleable castings . . . are high in sulphur . . . this element insists upon a somewhat lengthy anneal at fairly high temperatures with a view to bringing about malleablising largely in decarburisation.

"These remarks apply also . . . to the practice in France, Switzerland, Belgium and Germany."

This is a very different process, in principle as well as in results, from American malleable made from low-sulphur material and malleablised by converting the combined carbon of cementite into free temper carbon. British malleable, according to Hatfield, contains originally 2.80 per cent. to 3.50 per cent. carbon and various amounts of the other elements as given in Mr. Hurren's analyses. All these determinations show a typically low manganese, ranging from 0.04 per cent. to 0.13 per cent., except when raised in the experiments with steel additions. They also show a typical high sulphur content, varying from 0.22 to 33 per cent. in this element. The effect of this anneal, which was carried out at from about 590 to 1.000 deg. Cent. for from 72 to 120 hours, has been to reduce the total carbon to between 2.96 and 1.25 per cent., depending on experimental conditions. From 0.57 to 2.68 per cent. carbon was left in the combined state, the remainder being free, or temper carbon. A typical annealed iron under American practice would contain carbon, 2.50 per cent.; silicon, 0.70 per cent.; manganese, 0.28 per cent.; sulphur, 0.06 per cent.; phosphorus, 0.19 per cent. This would be converted by annealing into a metal having a total carbon of 1.75 per cent. and a combined carbon of 0.10 per cent.

It will be seen that while the British product occasionally may contain amounts of free carbon as great as found in American practice, it always contains a much greater percentage of combined carbon than any malleable iron encountered in this country. This is due to the high content of iron sulphide, which entirely prevents the complete breaking up of combined carbon, even under severe temperature conditions.

Mr. Hurren's micrographs show this combined carbon, as pearlite, occupying a large part of the metallic area in each of his fields. It is the presence of this pearlite which imparts to British malleable its characteristic strength of around 26.7 tons per sq. in. and its characteristically low elongation of 5 per cent. and under. The product corresponds in properties closely to under-annealed American iron, which, as properly manufactured, has a tensile strength of about 22.3 lbs. per sq. in., and an average elongation of 10 to 12 per cent.

To this pearlite structure the material also owes its *steely* fracture, from which the name *white heart* malleable is derived. To get high ductility the only recourse under European conditions is to decarburise almost completely, an end impossible of attainment in heavy sections.

In America the freedom from combined carbon is attained by a process of graphitisation, not necessarily accompanied by any decarburisation. This process takes place throughout the mass, and can be applied to pieces of almost any size.

The Effects of Heat Treatment on Structural Steel Castings.*

BY P. OBERHOFFER and F. WEISGERBER.

In 1912 Mr. Oberhoffer observed that two kinds of structural steel castings of the same chemical composition, heat-treated in a similar way, showed important differences in tensile strength. While this matter was under investigation Arend's work appeared, which showed the influence of wall-thickness on the properties of structural steel castings, and especially the connection between wall-thicknes and internal structure. Differences in wall-thickness naturally imply differences in cooling, and consequently differences in structure, especially with regard to the formation of ferrite and pearlite. The authors consider this question at length, and arrive at some definite conclusions. The investigation was carried out on three kinds of cast steel, non-heat-treated and heat-treated. The results are in agreement with Arend's views—namely, that in the non-heat-treated metal the tensile strength increases as the wall-thickness increases, but that in the heat-treated metal a decrease is shown, and that expansion and contraction increase independently of heat treatment. Moreover, microscopic examination shows that the grain of the primary and the secondary structural elements increases with the wall-thickness, and that heat treatment has no effect on the former, while its effect on the latter is to make the grain more uniform in size. The latter circumstance favours the assumption that with the increasing size of grain of the primary constituents of the structure (crystal segregation) the tensile strength diminishes, while expansion—dilation—becomes greater. This assumption, however, requires further support. A number of micrographs are given showing changes in structure.—"Stahl u. Eisen."

TENDERS FOR AUSTRALIAN RAILWAY MATERIAL. — The Imperial Trade Correspondent at Adelaide has informed the Department of Overseas Trade that tenders will be received at the Supply and Tender Board Office, Adelaide, until 3 o'clock p.m. on May 18, for the supply of the following railway materials, delivered in trucks, on wharf, Port Adelaide, wharfage to be paid by the contractor:—267 bars of channel steel, 139 bars of angle steel, 368 steel plates or bars, 300 steel straight axles, 800 carriage and wagon tyres, 897 engine and tender tyres, 24 straight axle forgings, 18 mild steel smokebox tubeplates for flanging, 100 mild steel boiler plates. The materials are subject to the inspection, test, and approval of the South Australian Government Inspecting Engineer in London. Specifications may be seen and forms of tender obtained, at the office of the Agent-General for South Australia, 112, Strand, W.C 2.

Local representation is essential, and, in view of the limited time allowed for tendering, it will be necessary for firms wishing to submit offers to instruct their agents by cable.

* Institute of Civil Engineers Foreign Abstracts.

Some Notes on Centrifugal Castings.*

By J. E. Hurst.

The earliest recorded patent referring to the production of castings in metallic bodies by introducing the molten metal into rapidly rotating moulds dates back to the year 1808. This patent was taken out by Anthony Eckhardt, of Soho, Birmingham, England. Since this time a number of patents are to be found recorded in the patent journals, but it is only of recent years that this method has been seriously considered as a commercial method for the production of castings in cast iron.

The process with which the author is at present connected is briefly described as follows:—The mould, which is made of metal, is rapidly rotated by means of suitably designed machinery. The molten metal, carried in a pourer, is poured into the mould whilst rotating about the horizontal axis, when, by virtue of the centrifugal force, the molten metal takes the required outer form of the mould, and the inner surface of the castings is truly cylindrical about the axis of rotation, and no cores are required to produce this internal form. The speed of rotation of the mould in this process is comparatively high, and it is important to bear this in mind, as many processes are often described as centrifugal processes in which the sand moulds are rotated at comparatively low speeds after the moulds have been filled with molten metal. The speeds used in the process with which the author is connected are of the order of 12,000 ft. per minute.

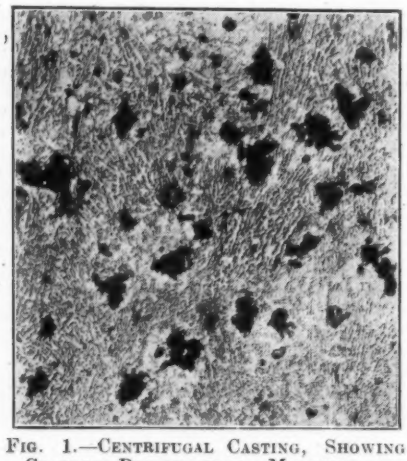

Fig. 1.—Centrifugal Casting, Showing Graphite Distribution. Magnification of 150 Diams. (Slightly Reduced in Reproduction).

Before considering the metallurgical characteristics of centrifugally cast iron, it is necessary to outline briefly the commercial advantages of the process. The advantages of the process can be summarised as follows:—(a) The absence of cores; (b) the absence of runners, risers, gates, and feeder heads; (c) the general uniformity and accuracy of dimensions of the finished casting; (d) the absence of sand in the moulding process, and the almost total elimination of fettling processes to which sand castings are subjected. The absence of cores and the reduction of labour costs in the fettling of castings by the elimination of sand and the absence of gates, runners, risers, and feeder heads, which are often costly to remove from castings, allows of a considerable reduction in the costs of the finished castings, and all tends to increase the rate of production of finished castings. In the heavier types of castings, such as Diesel engine and other internal combustion engine liners, it is probable that the rate of production of finished castings from a centrifugal casting plant would exceed that of the best sand casting processes. The absence of sand, and the general uniformity of the dimensions of the castings produced on centrifugal casting machines offers considerable advantages from the machine shop's point of view. The castings are free from the sandy skins, which are the cause of much trouble in the machine shops, and the reduced machinery allowances possible, apart from making towards a big saving in initial cost of materials, allows of considerable economy of time and labour in the actual machining operations. The machining allowances can be reduced to very fine limits and an average allowance of 2 mms. on both diameters of a cylindrical castings is well within everyday practice.

In addition to its advantages, the centrifugal casting process has its limitations, and the most important of these is that the process is confined to comparatively simple castings having a plain cylindrical internal bore. There is, of course, no technical reason why castings of complex and intricate design should not be produced by centrifugal means; it is entirely a matter of mould design. The expense, both in the actual manufacture of such complex moulds, and the initial experimental work invariably entailed before such moulds can be put into successful commercial production, is such as to limit the process for all practical purposes to articles of a plain cylindrical nature, or articles which are symmetrical about a cylindrical interior.

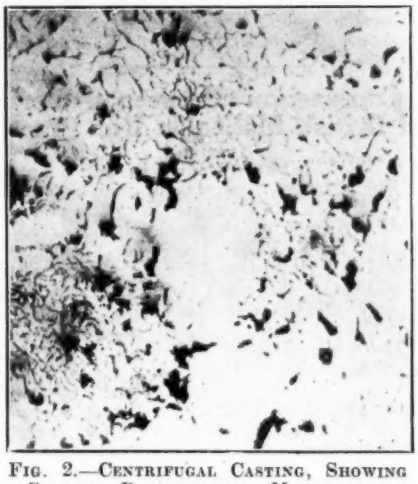

Fig. 2.—Centrifugal Casting, Showing Graphite Distribution. Magnification of 500 Diams. (Slightly Reduced in Reproduction).

Speaking broadly, internal projections on the inner bore of such castings, or cylindrical articles having closed ends, could not be readily produced; but external projections, in the shape of flanges, lugs, bosses, or fins, were much less difficult, and, in many cases, comparatively easy, to produce.

The other outstanding limiting feature of the process was the necessity for comparatively large quantities of one particular type of casting to enable the process to be operated on satisfactory commercial lines. In the case of plain, simple cylindrical castings, small quantities of from 100 upwards can be commercially produced, according to the character of the casting, and according as the degree of complexity of the casting increases, so the quantities for economical production are required to be larger. This covers the broader aspects of the advantages and limitations of the process from a commercial point of view.

Properties of Centrifugal Castings.—Turning now to the properties of centrifugal castings, the necessity for comparing the properties of these castings with those of sand castings on a truly comparative basis is essential. It will, of course, be obvious that a true idea of the effect of centrifugal casting, as opposed to sand casting, can only be obtained when a comparison is made between samples in which, as far as one knows, all

* Lecture before the Newcastle Branch of the Institution of British Foundrymen.

the other conditions are constant. It is necessary to bear this carefully in mind. A series of comparative tests on sand cast, rotary cast, or centrifugal cast, and castings made in stationary chills were given by Mr. Harley in a Paper before the Birmingham Branch of the Institute of British Foundrymen, November 10, 1919. In a final table giving the average results of various makes of piston rings by each of the above processes, Mr. Harley's tests show that superior tensile test figures are obtained from stationary chill castings, as opposed to rotary chill castings. An inspection of the average chemical composition figures will show at once that it is not justifiable to ascribe this difference in test results to the method of casting, and there are large enough differences in the chemical composition to account for the difference in mechanical properties.

It is generally agreed that the production of cast-iron castings under conditions of rapid cooling in metal moulds produces in an iron of given composition a much closer grained structure, which is accompanied by higher tensile strength values.

TABLE I.—*Showing analysis and tensile strength of centrifugal castings.*

Sample.	Tot.	CC.	Gr.	Si.	Mn.	S.	P.	Max. stress. Tons per sq. in.
31 L.	2.78	0.46	2.32	2.52	0.36	—	0.86	18.6
31LP.	2.99	0.43	2.56	3.01	0.45	—	0.22	21.4
32HP.	3.08	0.33	2.75	2.78	0.72	—	1.31	18.0

FIG. 3.—SAND CASTING, SHOWING GRAPHITE PLATES. MAGNIFICATION OF 100 DIAMS. (SLIGHTLY REDUCED IN REPRODUCTION).

The American authority on cast iron, Dr. Moldenke, speaking some time ago in America, disagreed with this, and stated that in his experience cast-iron chill or permanent mould castings were not so strong as similar sand castings. This experience is certainly different from that of the majority of foundry men in this country, and it is probable that Dr. Moldenke had in mind the possibility of weakness occurring in permanent mould castings of complex design, due to the presence of internal stresses, which, in such castings, may be much greater in magnitude than in similar sand castings.

By virtue of the use of metal moulds alone, centrifugal castings show increased tensile strength values over sand castings of similar composition. The average values obtained in a series of recent experiments are given for the purposes of comparison, along with the results of sand-cast material of similar composition in Table I. The whole of the tensile test figures recorded in this table are direct tests made on specimens machined from actual castings, and are not derived results obtained from tests made on curved rings.

At the present time the author has no quantitative evidence to put forward which would enable a definite conclusion to be made regarding the influence of the centrifugal action on the mechanical properties of the resulting castings. There is no doubt that the solidification of the molten metal under conditions of agitation tends to assist in the production of a solid metal having a much finer crystalline structure—a fact which can be readily confirmed by an examination of the grain size of centrifugally cast non-ferrous metals, in which the grain boundaries can readily be rendered visible in microscopic examination. The centrifugal action has, however, certain other well-defined advantages, which will be briefly described at a later stage.

The increased mechanical properties of centrifugal castings are readily understood by an examination of the microstructure of this material. The following microphotographs illustrate the characteristic distribution of graphite in centrifugal castings. Fig. 1 shows the unetched specimen of centrifugally cast material at a magnification of 150 diams., and shows the characteristic distribution of the graphite in centrifugal castings. Fig. 2, from a similar specimen taken at a higher magnification, shows more clearly the minute size of the individual graphite plates and their tendency to aggregate into isolated colonies. Fig. 3 shows the characteristic plate-like form of the graphite in a sand casting of similar composition and dimensions as the above, taken at a magnification of 150 diameters. Fig. 4 shows the structure of a polished and etched surface of a centrifugal casting. The well-marked network distribution of the phosphide eutectic is strikingly illustrated in this specimen.

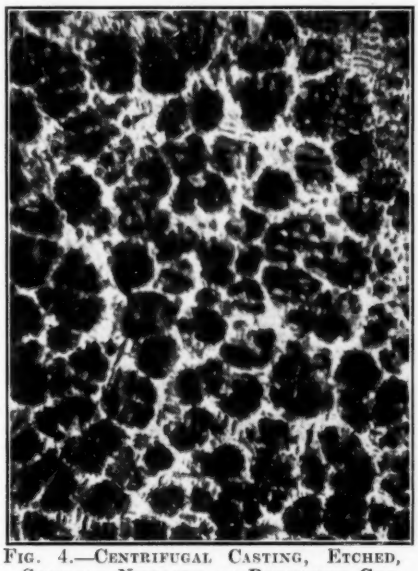

FIG. 4.—CENTRIFUGAL CASTING, ETCHED, SHOWING NETWORK OF PHOSPHIDE CONSTITUENT. MAGNIFICATION OF 100 DIAMS. (SLIGHTLY REDUCED IN REPRODUCTION).

Apart from any considerations as to mechanical properties, the influence of the centrifugal action is of importance from other points of view. The most important aspect lies in the segregation of the insoluble constituents of the molten cast iron. Under the influence of the centrifugal action, the lighter insoluble constituents of the molten cast iron are moved to the inner surface of the casting. Slag and such like inclusions in the molten metal collect readily on the inner surface of the casting, from which position they can be easily washed out by pouring a slight excess of molten metal into the mould. The segregation of the manganese sulphide in the molten metal to the inner surface of the castings on account of its insolubility in and its lower specific gravity than that of the main body of the molten metal, can be readily removed by pouring excess metal into the mould. The use of low manganese irons, in which the sulphur exists as the iron sulphide, and which, being soluble, does not segregate under the influence of the centrifugal action, or by raising the temperature of casting of the ordinary metal to such a degree that the manganese sulphide existing therein is rendered soluble, in which condition it is not influenced by the centrifugal action.

XUM

Making a L.P. Cylinder in Loam or Dry Sand. Part II.—Moulding.

By "Ben Shaw" and "James Edgar."

The methods employed in the production of sound castings for reciprocating cylinders vary considerably in different parts of the country. Even in any one district two foundries may differ in the method they adopt for a similar type of cylinder. There are many factors responsible for the diversity of opinion existing in connection with this class of work. One of the main influences in the selection of a particular method is undoubtedly the practice usually employed on the special type of work. When the moulders responsible for the preparation of the mould are highly skilled in one particular method, even though that method may not be considered the best practice, it is not wise to depart from it unless the castings made in previous instances have not been all that could be desired. As a rule founders do not care to depart from customary practice because of the large amount of new tackle which would invariably be involved.

When quantities of a similar type of cylinder are required, such as was experienced during the war, then, from the point of view of economy in labour and speed in production, it is essential to devise some method which will give good results at low cost, but it is rarely that the system in a foundry is changed entirely, the principle upon which they have been previously made being maintained with slight modifications to ensure greater speed of production. In ordinary times the size and design of cylinders are constantly varying, and it is rare that two castings are required exactly alike. Foundry conditions and the

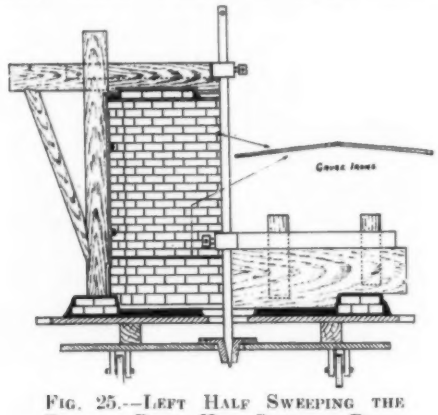

Fig. 25.—Left Half Sweeping the Pattern, Right Half Sweeping Print and Bearance.

facilities available are important factors in governing the final selection of the most satisfactory method for any one foundry, and, while we propose describing a number of methods in this article and to touch upon the relative value of each, it must be understood that the foundry conditions have a controlling influence in the method finally selected.

A full pattern is usually supplied for a H.P. cylinder, and sometimes a similar provision is made for an I.P. cylinder, but it is only in exceptional cases that this additional expense is incurred for a L.P. cylinder. Sweeping boards having a profiled edge to form the cylindrical shape are supplied, and subsidiary pattern work is made to complete the means for obtaining the necessary impression.

The practice most commonly adopted for L.P. cylinders consists in making a loam pattern to which the subsidiary pattern work is attached. Two sweeping boards and a gauge-stick are required for this purpose. A substantial foundation plate is necessary upon which to build the pattern. The type shown in Fig. 26 fulfils requirements, but frequently these plates are made to the shape indicated by the dotted lines so that they will accommodate a greater variety of sizes in steam chests. This plate is located on a suitable bogie, having a socket to it for the vertical spindle. A machined spindle about 2½ or preferably 3 in. in dia., and having one end tapered off, as shown in Fig. 25, is introduced into the socket so that it will maintain a vertical position while being rotated.

The first board to be used sweeps out a print, and provides a bearance upon which the pattern is to be built. It is so cut that the inside edge fits against the spindle, and very little adjustment is necessary when setting. A spider or tail-piece

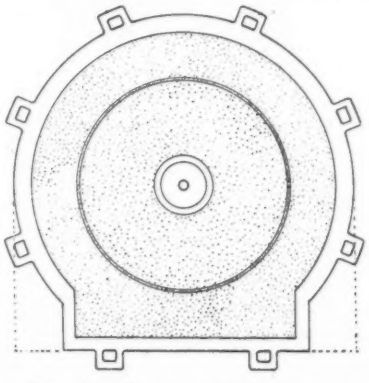

Fig. 26.—Plan of Bearance and Print.

of convenient length is lowered over the spindle, and secured to it at a suitable height for the board. Either bolts or clamps may be used to fix the board to the spider, and it is advisable to test its accuracy by means of a level.

There are other methods adopted for supporting the vertical spindle. Some foundries prefer a top brace, either with the spindle a fixture, when the spider rotates about it, and is maintained at a definite height by collars, or top and bottom sockets may be used to enable the spindle to rotate with the board. The method illustrated in Fig. 25 has the advantage of being useful on any part of the loam floor, and is not confined to positions near to a wall or column. When the top of the spindle is free it may rotate slightly out of truth owing to the weight of the board and the operation of sweeping, but the difficulty can be overcome by using a counter-balancing weight over a grooved pulley at the top of the spindle.

When the print board is set so that it just clears the short dabbers which are cast on the plate, loam can be applied and the board rotated to sweep the shape. The height to the bearance

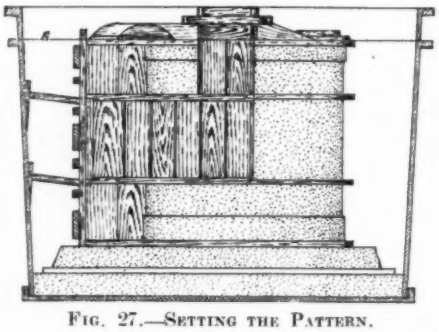

Fig. 27.—Setting the Pattern.

can be made up with bricks interspaced with loam, or dried loam may be worked into the soft loam to stiffen it while sweeping; it is the usual custom, however, to introduce at least one layer of bricks.

Both the boards shown in Fig. 25 are made to sweep in a counter clockwise direction, the moulder using the left hand to rotate the board and the right hand to apply bricks and loam. Some foundries reverse the method, it being only a question of custom.

A plan of the print and bearance swept up is shown in Fig. 26, and a sectional elevation showing the board in position is illustrated on the right of Fig. 25.

When the bearance has been formed and the board removed it may be dried, but it is not essential that it should be; it will suffice if it is allowed to stand until the loam becomes stiff.

The board for sweeping the pattern or dummy, as it is sometimes called, has the inside edge cut to fit against the spindle to give the desired diameter, but a gauge-stick is necessary to set it parallel with the spindle. Instead of making the board parallel with the spindle, the experienced moulder will increase the size at the bottom to allow for the greater contraction which takes place at the open end of the cylinder. It is good practice to use a piece of thin sheet iron to separate

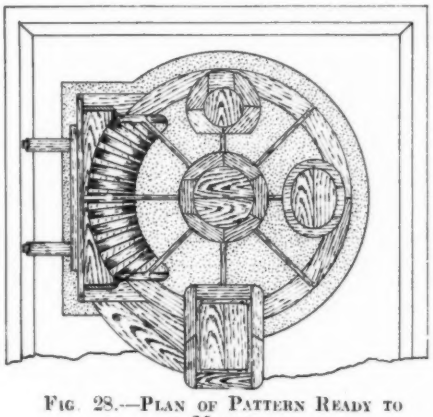

Fig. 28.—Plan of Pattern Ready to be Moulded.

the bottom edge of the board from the bearance. When this board is correctly set and secured to the spider the construction of the loam pattern can be commenced. A dusting of parting sand should be applied to the bearance if it is green, then loam and bricks are used to build up the shape. The brick work for a temporary pattern of this description need only be strong enough to withstand ramming, therefore the wall thickness is not important. It is better if the actual building is done first, leaving the bricks clear of the board about ½ in. When the building approaches the top it is necessary to have a top plate to carry the shape of the end of the cylinder. Loam is worked against the brick work and the board rotated until the final shape is obtained. A good surface is given to the pattern if a very wet mixture of loam is applied for the final sweeping. A section of the completed

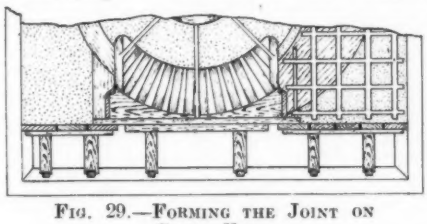

Fig. 29.—Forming the Joint on Chest Face.

pattern is shown in Fig. 25. The practice prevails in many foundries of making a couple of gauge irons to the most common diameter of the required pattern, and these are inserted at convenient places in the brick work and serve as a guide to the moulder when sweeping. These gauges are set at right angles to each other, as indicated in the sketch. This plan saves the necessity of calliping the diameter. The swept-up pattern needs thoroughly drying.

This form of pattern may be used to prepare a loam or dry-sand mould. When the former method is adopted it is usually built above the floor, and a considerable amount of tackle is involved to retain the brick-work, and when the mould is ready to receive the metal it is customary to sink the mould in a pit and ram sand about it. This is done as a precaution and to assist it in resisting the strain and pressure during the time of casting. While this form of moulding is adopted in some districts, especially where loam work is considered a speciality, it is an expensive method, particularly when there is constant need for new tackle. When facilities are available, the use of dry sand offers many advantages. A pit or case is required into which the pattern is lowered. A cast-iron case or box having a bottom is best; if the case is tapered, as shown in Fig. 27, the casting is more easily withdrawn after it has cooled down. The advantage of having a cast-iron case with a bottom is obvious, as it gives better facilities for drying and prevents the absorption of moisture from the sand floor into which it is bedded. Whether a pit or case is used, it is necessary to prepare a level bed at a depth from the floor level equal to the height of loam pattern and the foundation plate. Sometimes the height is taken to the top of the flange, as shown by A in Fig. 27; that is, corresponding with the height of the loam pattern. Invariably, however, the full height of the job is taken into consideration, so that the prints of the stuffing box and feet just reach the level of the floor or case. With the desired height marked off on a lath, the moulder can proceed to make a bed at the required distance from the top.

Two parallel logs are bedded into the sand and tested with a spirit level, sand rammed in between and about them, and strickled off to the surface of the logs.

When the dried loam pattern is lowered on this prepared bed the patternmaker's assistance is required to attach the subsidiary wood pattern sections. Setting off the pattern, as it is termed, carries with it a certain responsibility, as on it depends the accuracy of the finished casting. Four centre lines are required to be erected vertically about the loam pattern; against one of these,

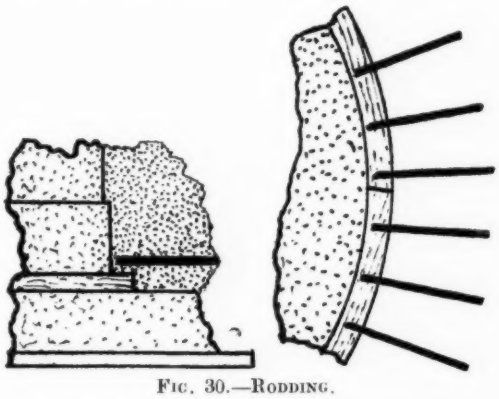

Fig. 30.—Rodding.

and with its centre coinciding, is placed the chest. This section rests flat on the bearance, and it can be maintained in its correct relative position by means of stays wedged against the case, as illustrated in Fig. 27. When a full top flange is supplied in wood for the crown, its position is more easily located than when segmental flanges are used. The relative positions of the two feet are, however, simplified in the setting if they are secured to edged battens passing over the top of the stuffing-box print, as shown by the dotted lines in Fig. 28. The recess swept in the loam pattern defines the position of the stuffing box, and it is only necessary to make sure that the centres of the feet coincide with those on the pattern. When these are in position it is not difficult to fix the exhaust belt with the aid of buttons. The top and bottom flanges, and also the ribs, are merely laid in position, and the remaining sections located to the crown. Each of the parts which come in contact with the loam pattern should be scribed so that they may be easily replaced if it is desired to remove any of them during the time of ramming the mould. Figs. 27 and 28 show an elevation and plan of the pattern set up ready for ramming. The patternmaker should test important dimensions before he leaves the job, particularly the chest face, the feet centres, and the position of the steam-way piece on the crown.

The work is now in readiness for a commencement with the mould.

The impression of the face of the steam chest is preferably carried on a plate, which can be lifted out so that the steam and exhaust cores may be secured to it, and then lowered into the mould at one operation. This practice necessitates a joint off the face of the chest, and boards are wedged in position to enable the moulder to ram the sand against, as shown in Fig. 29. Much of the pattern work attached to the body is removed, to be replaced as the moulder approaches the position when ramming. The flange sections resting on the bearance simply fit against the body, and facing sand is placed next to these.

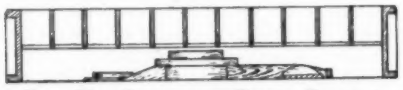

Fig. 31.—Section of Cover Box for Level Joint.

and, with the ordinary floor sand as a backing, ramming is resorted to. Owing to the pressure exerted by the molten metal at the bottom of a job of this nature, it is necessary to make the sand more dense at the bottom than at the top. To carry the sand over the flange rodding should be resorted to. This consists in introducing pieces of ½ to ¾ in. iron, either wrought or cast, and anything from 9 to 12 in. in length.

These are bedded into the sand just over the flange, and radiating towards the centre of the cylinder, as shown in Fig. 30. They should be about 5 or 6 in. from each other. This practice

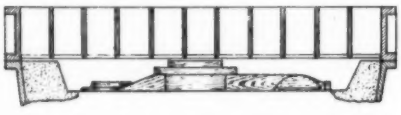

Fig. 32.—Section of Cover Box for Dropped Joint.

is advantageously employed about every 10 or 12 in. in the height of the work, particularly where sand is to be carried over projecting pattern sections. They give additional support to the sand if they are dipped in clay-water. The process of ramming is continued until the position of the first circular rib is reached, the segmental sections introduced, and the work of ramming proceeds.

When the top of the exhaust belt is reached, it is necessary to make a special grid to carry the sand to be rammed over it. The type of grid

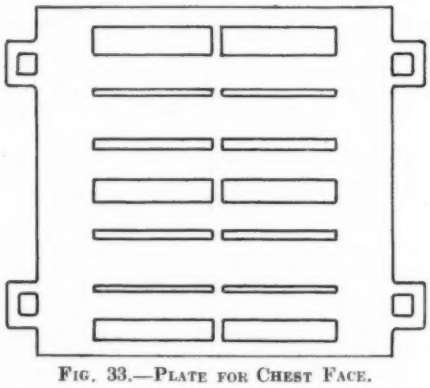

Fig. 33.—Plate for Chest Face.

suitable is shown in Fig. 29. This is also clay-washed and bedded into a covering of sand. Many moulders prefer to bring a riser off this part of the cylinder, as there are possibilities of gases being trapped; hence a riser stick would need to be set before proceeding with the ramming. When the sand has been rammed to the top of the case it is necessary to make a joint. Should the joint coincide with the end of the cylinder body and the top of the case, then only a straight joint is required, as shown in Fig. 31; but if the end of the cylinder is below the top of the case—the practice which is more common—it is necessary to shape the joint as shown in Fig. 32, the joint being flush with the end flange and then tapered well back to the level of the case. The latter method is preferable, as it only involves the use of a plain cover box, which could be used for any job having a joint off the top of the case. The other method involves a deeper cover box, and it is not nearly so useful for other classes of work likely to be made in the case. Figs. 31 and 32 illustrate the two methods.

Before a commencement can be made with the cover it is necessary to make up the chest face. For this purpose a cast-iron plate is made, having a series of holes cast in to coincide with the prints on the chest, and one surface a number of short dabbers. Snugs are cast on the vertical edges, as shown in Fig. 33. The plate is made sufficiently wide to get good support from the joint at each side of the chest. Loam is applied

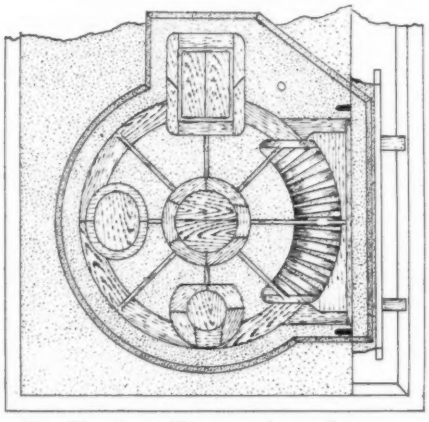

Fig. 34.—Plan Showing Joint Recessed.

to the chest face, embedding the prints, and the plate, previously clay-washed, is bedded into the loam and wedged up from the side of the case to get a good impression. Frequently the joint on the chest face is stepped back to define its relative position when resetting, as shown in Fig. 35. In this instance also the medium used for taking the impression is loam. When the chest plate has been set the joint for the top can be completed. The general contour of the recessed joint is illustrated in Fig. 34. It is important

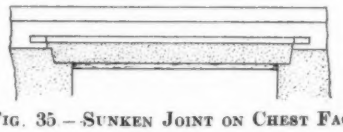

Fig. 35 – Sunken Joint on Chest Face.

that a considerable taper should be given to the sides, so that the least possible resistance will be offered against a clean lift.

Many cylinders moulded in this way receive the metal by way of vertical flanges on the chest, and for this purpose a long gate-stick is introduced into the face during the time of ramming,

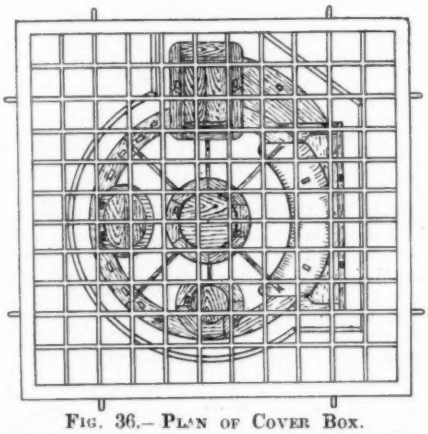

Fig. 36.– Plan of Cover Box.

and on each side of the chest. The gate-sticks should be about 2½ in. square, and long enough to reach the joint from the bottom bearance.

From these gates a series of sprues are cut after the job is stripped to form a spray. A runner is usually formed at each side and on the joint, as shown in Fig. 34, to break the continuity of the ingate which reduces the strain upon the mould. While this method of pouring the job is adopted, the more common practice is to supply the metal by way of a series of gates following the thickness of the cylindrical part of the casting. They are preferably so placed that the streams of metal will clear any projecting cores. The number and size of these gates vary, but usually from eight to ten are used, and the area of each at the point of contact with the mould is generally from 1½ to 1¾ in. by ¼ in. Riser sticks are also necessary, particularly at the high parts

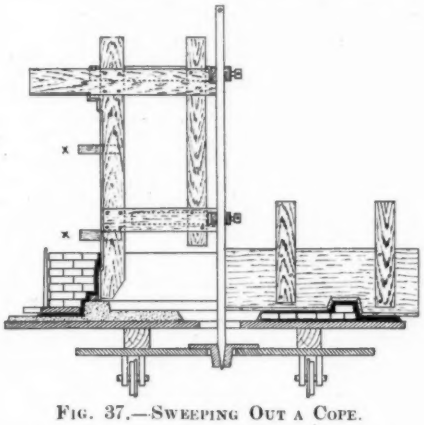

FIG. 37.—SWEEPING OUT A COPE.

of the mould. Fig. 36 shows the disposition of the gates and risers.

When the position of the gates has been decided a commencement can be made to cover the mould. It is common to make use of loam especially around the sand joints, and it is a good practice, as it reduces the difficulties of ramming. Loam may be used with advantage over the whole surface of the sunken joint and pattern.

There is considerable lift to be taken with the top box, and gaggers must be introduced, or, better still, grids, in order to strengthen the sand and connect it with the box part. Odd bits of grid are useful for this purpose, providing they can be secured to the box. They are clay-washed and bedded into the loam, and either fastened with S hooks or by means of staples. When the

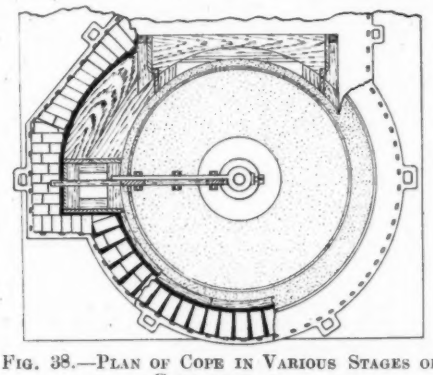

FIG. 38.—PLAN OF COPE IN VARIOUS STAGES OF CONSTRUCTION.

grids have been set and the cover partly made up, the cover box is lowered into position and sand rammed in flush with the top. A plan of the cover box in its relation to the pattern is shown in Fig. 36. When ramming the top it is only necessary to take an impression of the sunken part of the joint, therefore a considerable part of the box need not be filled.

Though the principle of casting large with the open end down is maintained, in some districts preference is given to the method of sweeping out the cylindrical shape rather than making a dummy pattern. The method is known as sweeping a cope, and it involves the use of loam in the formation of the mould instead of sand. A bearance is required somewhat similar to that previously described, but frequently a seating or guide is also swept, as shown in Fig. 37. This guide is only necessary when it is considered desirable to lift the cope after it has been swept and dried.

The cope board is fixed against the spindle so that the profiled edge is at the correct distance from the centre. A large bottom plate, having

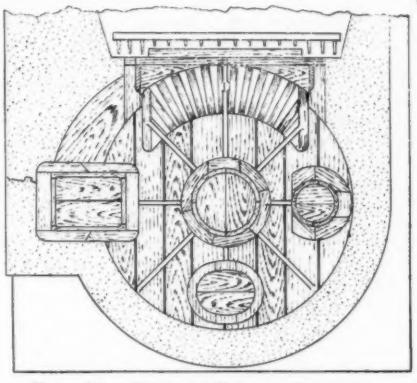

FIG. 39.—SETTING CROWN PATTERN.

gaggers cast about the outside to hold brickwork, is bedded into loam applied to the bearance. Loam and bricks are used to build up the shape, special facing loam being applied next to the board, which is rotated with the spindle to give the required shape. It is necessary to make

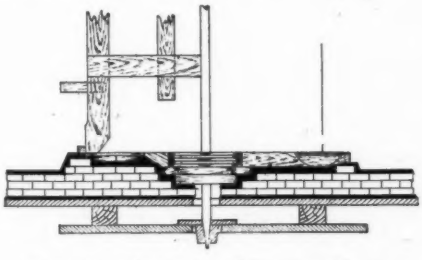

FIG. 40.—METHOD OF SWEEPING CROWN DOWN.

up a special bearance for the chest pattern, and other subsidiary pattern sections are set as the building operations proceed. The bottom flange segments are placed directly on the bearance, and as it approaches the position for the circular ribs,

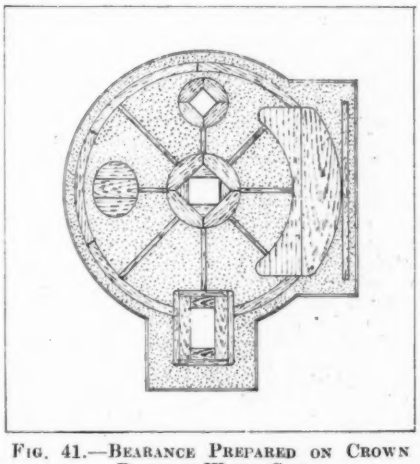

FIG. 41.—BEARANCE PREPARED ON CROWN PATTERN WORK SET.

temporary pieces, shown by XX in Fig. 37, are fixed to sweep a bearance upon which the segmental pieces can be laid. All the pattern work is made slightly clear of the board, so that it will rotate freely. Fig. 38 shows a composite plan of a number of positions in the course of building.

Plates having suitable gaggers cast on are necessary about every 12 in. in building the cope, and when the top is reached and the bearance for the cover swept, the whole job is dried or allowed to stand until the loam is sufficiently stiff to proceed with the work. It is customary to prepare a full pattern for the crown when the cylinder is made in this way, and its position is located by means of the chest and the recess swept out for the flange. Sometimes the cope is carried high enough to form a dropped joint, somewhat similar to the previous method, and a plate is used take the cover grids being bedded into the loam and secured to this plate in order to carry the loam when the cover is lifted. Fig. 39 shows the pattern work for the crown set ready for making the cover; it also indicates the joint required for taking the impression of the chest face. This joint should be tapered considerably, so that the drawback can be lifted vertically.

Another method for making these moulds is to prepare them with the crown down. This practice is not so frequently employed, excepting for cylinders having a double crown, when it is advisable to cast the crown down in order to ensure sounder metal. When this practice is resorted to a head is usually cast on the open end, varying in height from 6 to 18 in. In preparing the mould for casting in this way various methods are adopted. It is the general practice, however, to make up the crown part in loam, and considerable attention must be given to the venting arrangements for the feet. When the mould is to be made in sand it is customary to finish the crown mould before it is lowered into a case, and a loam pattern, swept up separately, is set upon it in its correct relative position and sand-rammed about the outside. When loam is used, either the crown is finished as before or a joint is prepared to enable the cope being lifted in order to finish the bottom.

Fig. 40 shows the general arrangement when the mould is to be made in loam, and Fig. 41 shows a plan of the crown prepared and ready for commencing the operation of sweeping out the cope.

Molybdenum Steels.

In the course of a Paper before the American Institute of Mining and Metallurgical Engineers, Dr. John A. Mathews (of the Crucible Steel Company of America) remarked that the manufacture of molybdenum steels was discontinued almost before the patents had been allowed. One of these patents had now expired, but "discoveries" of chrome-molybdenum-vanadium steel and molybdenum-vanadium steel for high-speed purposes were recently announced. Both of these types of steels were made and abandoned nearly 20 years ago, as they were found to be unsatisfactory. Occasionally these steels gave extraordinarily good service, as measured by the standards of that time, which were much below the present standards of the leading high-speed steels. However, notwithstanding the discouraging results of the earlier experiments, the author had felt that sooner or later molybdenum would have to be used, due to shortage of tungsten or for other economic reasons.

One of the principal difficulties with molybdenum in high-speed steel was its tendency to volatilise at the high temperatures necessary in the working and hardening of the steel. After prolonged or excessive heating, a well-defined zone on the outside of the bars or tools was entirely different from the interior in structure, and, as a result, finished tools, such as drills and cutters, which could not be given the grinding permissible with lathe tools, were not satisfactory; this had greatly limited the use of molybdenum high-speed steels. Both vanadium and cobalt had been tried in an endeavour to overcome this difficulty. Recently it was stated that cobalt and vanadium were "stabilisers" for molybdenum, but there was no evidence to confirm these claims. On the other hand, molybdenum high-speed steel containing either or both of these elements had shown the defect in a marked degree. Some experiments now in progress promised more satisfactory results, but it had not been determined whether the "stabiliser" in any way impaired the cutting qualities or not.

Cobalt-molybdenum-vanadium high-speed steel was made and abandoned in America before the beginning of the war, for it was found inferior to the regular tungsten-vanadium steel products with or without cobalt. After reading recently that cobalt-molybdenum-vanadium high-speed steel was the latest foreign contribution to tool-steel metallurgy, some of the cobalt-molybdenum-vanadium material made in 1914, some ingots made along similar lines in 1919, and some of the European steel were used in exhaustive and carefully conducted tests. The molybdenum products failed to give satisfactory results, and were rated much below the standard tungsten high-speed steels on the market to-day.

In the mills molybdenum steel had been found to work satisfactorily, being relatively as free from seams and similar defects as the older types of alloy steels; it was also freer from thick and tenacious scale than were the nickel and chrome-nickel types. It seemed to flow readily, particularly in drop forgings, and could be worked over quite a wide range of temperature, say from 2,100 to 2,500 deg. Fah., though the higher temperature would not be recommended for steel containing above 0.25 to 0.30 per cent. carbon.

The steel seemed to have a wide safe heat-treatment range, as measured by static tests; but it was not advisable to stress this point, as it led to carelessness in heat treatment. In addition, it had been found that static tests were somewhat misleading. While many steels of high quality could be forged or heat-treated through a considerable range of temperatures without apparent loss in static qualities, shock tests seemed to indicate that for every steel there was a temperature at which the maximum of static and dynamic qualities were obtained. Shock-test methods were of especial value in supplementing the knowledge of materials or even in detecting faulty heat treatments that static tests did not disclose. Molybdenum steels seemed to machine more readily at a given Brinell hardness than did other steels. This would mean, of course, that parts that must be heat-treated and machined afterward could be utilised in a state showing higher physical properties than had been customarily obtainable. The physical property on which molybdenum seemed to exert most effect was the reduction of area, which was usually considered a good measure of toughness.

Molybdenum, particularly in conjunction with chromium, seemed to confer the property of deep hardening. This was to be expected from the observation that molybdenum steels resisted the drawing temperature to quite an unusual degree. In other words, they required a higher drawing temperature to reduce the physical properties by the same amount that they would be reduced in similar steels without the presence of molybdenum. This indicated that molybdenum tended to keep the carbon in steel in the combined or martensitic form, and when in that condition to retard its passage to the sorbitic or troostitic state.

It was possibly too early to make predictions, but he (the author) believed that molybdenum had established for itself a permanent place among the alloy steels found useful to the airplane, automobile and general engineering trades. It would not displace wholly any other type of steel, but the effect of improvements of this kind and of new products had been rather to extend the field of usefulness than to eliminate products of previously demonstrated merit. Not only did molybdenum below 1 per cent. give no trouble from volatilisation, but it might be recovered from scrap to a large extent when remelted in the open-hearth furnace.

CHELMSFORD AND BELGIAN GAS-PIPES.—Alderman Taylor (the Chairman of the Gas Committee), in moving the acceptance by the Chelmsford Town Council of a Belgian tender for cast-iron gas-mains, said he was sorry to have to do so. The Belgian tender was £1,435, whereas the lowest offer from British manufacturers was £2,157. Mr. Harper pointed out that iron was produced more cheaply in Belgium than in Britain because coal was cheaper there. Alderman Taylor's resolution was carried.

The Pattern Store.—III.

A study of the methods of the general foundry will reveal the fact that there is a total lack of system in connection with the recording and the classification of patterns received from customers. The storage facilities are of a meagre description, and the result is that, on the one hand, the pattern does not always receive the care and attention to which it is entitled, this being manifestly unfair to the owner of the pattern, whilst on the other hand the foundry itself suffers, by reason of delay in locating the pattern required.

Quite often an order is received for certain castings, off a pattern (or patterns) which, according to the customer's record, is already at the foundry. After an interval of a few days, however, the customer receives from the foundry a request for the pattern; but upon the latter stating that the pattern is already at the foundry a search is instituted, but no pattern is located. Again the customer is apprised, and again he replies to the same effect. Ultimately, the pattern is discovered, but only after much delay, expensive alike to the customer and the foundry.

This annoyance could, of course, be obviated by an elementary pattern records system, but the founder does not appear to grasp the full value of the benefits likely to accrue. He is there to provide castings, and he grudges any time spent otherwise than in the moulding shop. Once the casting is completed, no further importance is attached to the pattern, it being apparently nobody's duty to take care of this. In course of time all patterns not in use are collected from the foundry, and these are dumped in a shed or a corner of a building until such time as they can be identified and restored to their respective owners.

Some of these patterns remain in the "dump" for years; this because the owner has never asked for them, or because, when asked for, the pattern could not be identified, and as a consequence could not be restored. Thus the so-called pattern store is nothing but a dumping place, and hours sometimes must be spent removing patterns in the endeavour to locate one specially required, either by the foundry or the owner.

Undoubtedly the customer is to some extent to blame for this deplorable state of affairs. In the first place, many patterns are not properly marked, and the name given to them does not in the least assist in identification. Then the customer is very like the founder—when once the castings are to hand interest in the pattern vanishes until it is again required, and thus it is that no recall is sent to the foundry at the completion of the order. When a request for the return of the pattern is ultimately made, the period which has elapsed since the pattern was last in commission, together with the other factors already mentioned, makes the task of locating somewhat formidable.

In the interests of efficient business, therefore, the onus is upon the general foundry to instal a system of pattern records and storage, and this need by no means be elaborate. In the first instance, every pattern received into the foundry, no matter from what source, should, whilst in the foundry, be looked upon not as the property of an individual customer, but as the property of the foundry.

Foundry Numbers.

Foundry Number	Customer's Number.	Customer's Name.	Name of Part.	Order Number.	Quantity of Castings	The Pattern. Date Received.	Date in Progress.	Date Completed.	Date Returned.
1	A.B.	Austin & Co.	Bracket	15723	4	30/3/21	2/4/21	4/4/21	6/4/21
2	112653	P. & J. Jones	Fork	89J	100	„	2/4/21	8/4/21	—
3	128	Brown, Ltd.	Sleeve	1060	500	„	—	—	—
4	CJ032	Phillips & Son	Base	837	10	31/3/21	3/4/21	—	—
5	CF143	„	Slide	837	10	„	3/4/21	—	—
6	427	Brown, Ltd.	Case	1061	500	1/4/21	—	—	—
7	AC	Austin & Co.	Cap	15728	4	„	3/4/21	8/4/21	—

FORM 1.—SHOWING SYSTEM OF RECORDING CUSTOMERS' PATTERNS.

This means that, no matter by what number the pattern is known to the customer, a proper sequence of numbers exists for the foundry identification. It is very confusing when a pattern from one customer is known only by a letter, A, B, and so on; that from another customer known as 112,653; another 128, and still another CJ032. These numbers are all very well from the customer's standpoint, but it must be admitted that they are likely to cause confusion in the foundry.

So, to facilitate identification and subsequent location, each pattern as received is given a foundry number, and entered into a book. This book is numbered consecutively as shown on Form 1, and thus pattern A, B becomes foundry number one, pattern 112,653 is foundry number two, pattern 128 foundry number three, and so on. It may be observed that in certain instances one pattern will be received into the foundry upon more than one occasion, but when this is the case a separate foundry number will be given each time the pattern is received. Thus pattern numbered CJ032 may be in the first instance alloted foundry number four, but the next time the pattern is received it is treated as an entirely new arrival, and receives the next vacant foundry number, which may be sixty.

The last column is for returns, and a periodical perusal of the book will show at once all outstanding patterns, and how long they have been in the foundry. Should a repeat order be received before the pattern has been released the new foundry number is given and reference made to

Pattern Record.

Customers' Name, PHILLIPS & SON. Pattern Location

Foundry No.	Customer's No.	Name of Part.	Quantity of Patterns.	Description of Pattern.
46	CJ032	Base	1	Wood

Date Received	12/4/21	General Remarks.
„ Handed to Foundry	23/4/21	One Core Box.
„ Returned from Foundry	30/4/21	
„ Returned to Customer	3/5/21	

FORM 2.—SHOWING THE PATTERN STORE RECORD CARD.

the number by which the pattern is at the moment known. When the first order is completed the item in the book is closed, and the pattern transferred to the new order.

The adoption of this system is a step in the right direction, but to ensure real success a pattern store, laid out in a methodical manner, must be in evidence. It may be that the foundry has one or more customers whose requirements are heavy and continuous, necessitating the housing of a large number of patterns. If this be the case, a section of the store should be set apart for the patterns of such a customer, and then location is a comparatively simple matter.

When the work is of a more general character, business being done with a large number of customers, the store can be laid out in bays, each bay being known by a letter, A, B, and so on. The customers' names are arranged alphabetically, so that the patterns belonging to, say, Austin & Company, Arkwright & Sons, etc., are stored in Bay A, patterns belonging to Brown, Limited, Bowen, Jones & Co., etc., in Bay B, and so on. This has the effect of localising patterns, and extended searching is thus eliminated.

The card record is upon similar lines. Where there is a predominant customer, a set of cards is reserved for the recording of his patterns, but otherwise the cards are filed alphabetically under the customers' names. This makes it easy to determine at any time just how many patterns belonging to a specific customer should be in the foundry, and also acts as a check upon the initial record.

It cannot be said that a great deal of work is involved in keeping up these records, and what time is spent upon them is more than justified by the time saved in other directions. A pattern records system imparts a businesslike air to the foundry and inspires confidence, apart from the material advantages it affords.

The foundry should make it a rule for the pattern to accompany the last consignment of castings, even though the chances are that a repeat order will follow. It is in the interests of the founder as well as of the owner that dilapidated patterns are not put into commission, and if the founder systematically returns patterns immediately the order is completed, the customer has only himself to blame if his patterns are not kept in good condition.

The system operates as follows. When an order is received from a customer, each pattern connected with the order is given a foundry number, the necessary particulars being entered in the book, as already described. The pattern, to which a tally is attached (this giving the foundry number, the customer's name, etc.), is sent to the pattern store, where a record card (as Form 2) is made out and the pattern then placed in store. In course of time the pattern is withdrawn for putting into process, and when the work is completed it is again returned to store.

In the meantime the clerk responsible for the initial record receives intimation that the pattern has been put into commission, and in due course that the order has been completed. He at once requests the storekeeper to return the pattern to the customer, and, upon being advised that this has been done, he makes the final entry, which completes the record of that specific foundry number.

It may be that when the request for return reaches the storekeeper the pattern has not been sent back to store, and it is the storekeeper's duty in such circumstances to collect the pattern from the foundry. This eliminates the possibility of a pattern lying about in the foundry after its work is done, and ensures not only speedy location, but also a minimum amount of damage to the pattern, such as is occasioned by ordinary wear and tear. This, in connection with a wood pattern, at all events, is very important, and is worthy of consideration.

The system can, of course, be elaborated, but enough has been written to show that it is a practical proposition, and can, with modifications to suit specific conditions, be applied to any foundry handling work to customers' patterns.

Efficiency in Management.

By J. McL.

During a visit to a small jobbing foundry in a Northern town the writer was surprised to learn from one of the proprietors that not only was no profit being derived from it, but it was actually being run at a loss. The place had been going for about two years, and had all the time been supported by the machine and fitting shops, and, strangely enough, the pattern shop. There had been no lack of orders; indeed, work had frequently to be turned away. At one time over twenty moulders were employed, but in order to reduce losses the number had been steadily reduced, and at the present time, there are only a few men and boys. The foundry is carried on because the plant is there and because it is convenient to have a foundry and also—and no doubt this is the principal reason—because the proprietors keep hoping, like Micawber, that "something will turn up," or at least that the foundry will ultimately pay. During subsequent visits it was obvious that the reason for the failure was not because of the foundry equipment, as to cope with the small class of work made there was nothing lacking, but owing to inefficiency in managing it.

The other shops in this small works pay well enough, presumably not because the management have had greater experience in conducting them, but because they produce a speciality and can demand a price. In the case of the foundry competition is keener. Some brass and aluminium work has been done, and the experience has been the same as with iron. The owners are satisfied that they are purchasing metal at keen prices, and also that they are not cutting in order to get work. Further, they have been particularly successful in having a very small proportion of "defectives." Presumably the moulders employed are of the average ability, and the foreman is a first-class craftsman.

Observation convinced the writer that the trouble in the foundry was that it was mismanaged. The foreman undoubtedly is not an organiser. It may not be possible or advisable for a foreman in charge of twenty men to work on the floor or at the bench, but it is sheer waste if a man with two or three men under him does not work. Further, the waste of material in the place was obvious; indeed, the foundry was an object lesson in how a foundry should not be conducted. Probably the men thought it a good place in which to work, but reflection would convince them that a badly-conducted workshop is never a good thing for the trade.

No place can be run on losses, and there is no reason why it should be. A foundry, like any other business, will give a fair return when properly conducted. But in no business is the personnel more important. Good equipment is important, a system of payment which will induce endeavour is important, but firmness in dealing with men and care to avoid leakages of any kind are all important. The foreman's position is, in some ways, more difficult to fill than the manager's, and especially is this true with regard to foremen in small shops, because they come in continual contact with the men, and the smallest action is criticised, and ambiguous remarks frequently misinterpreted.

The wise foreman will study the idiosyncrasies of those under him, and, as far as possible, cater to their desires. Some moulders, like other craftsmen, are good all-round men, but they are, nevertheless, better at one class of work than at another. We are not speaking now of loam and sand moulders, but of men who may be clever at big marine work, and very inferior on small, thin work, and *vice versa*. Boys also are not always as profitable as they might be. It is not economical to have a boy labouring, even if his wage is small.

It may well be that there were other reasons for the failure of the foundry in question than inefficiency of the foreman and slackness of the management, but these were certainly important causes. It is best for the industry if every unit of it is of the top class and producing to the limit, but there is no room to-day for businesses conducted in a haphazard fashion, and, taking a long view, more than the proprietors ultimately suffer.

Cast Iron.—II.*

The Strength and Properties of Castings.

(*Continued from Page* 380.)

By E. L. Rhead.

Carbon.—Cast-iron, when thoroughly molten, contains all its carbon in solution, so far as investigation has shown, as carbide. This lowers the melting point. This carbide is shown in plates on the fractures of highly carburised blister steel. The existence of the carbide depends on conditions. If an alloy of pure iron and carbon only be *very* slowly cooled from fusion the whole of the carbon separates in the free state.

In the cooling of carburised metal the indications are that concentration of the carbide, together with other components, takes place as the iron-rich body that first separates is formed.

During solidification of this carbide eutectic, the solubility of the carbide rapidly diminishes, free carbide separates and breaks up into graphite (Fig. 3), the iron being taken up by the mass. As cooling proceeds the iron-silico-carbide solution solidifies and retains some of the carbide in solid solution. Stead has shown that some silicide passes out with the carbide. The carbide thus retained is not permanently held in solution by the iron, but is separated and undergoes decomposition with a degree of ease dependent upon the amount of silicon present, as the metal cools. In high-silicon iron this separation and the dissociation to graphite are almost complete, leaving the basis of the matrix a solid solution of iron silicide in iron. The size of the graphite particles will depend on the ease of diffusion of the substances and the rapidity of the dissociation. Very slow cooling, which prolongs the period of easy diffusion and concentration, leads to the formation of larger carbide plates and graphite flakes. The silicide is also capable of diffusion. With uniform diffusion and decomposition the precipitated graphite will be in small particles more or less uniformly diffused, and the interference with the continuity and strength of the structure is less.

It is not the carbon thus separated that reduces the strength of the casting. The action is similar to that occurring in the production of black-heart castings, and to softening castings. In these cases the separation of the graphite which was arrested by the rapid solidification of the iron is allowed to complete itself under the heat treatment. The action of the silicon in effecting this change is shown by the following figures obtained by Charpy and Grenet in annealing experiments:—

Silicon per cent.	Temperature at which C began to separate.
0.07	1150° C.
0.27	1100° C.
0.80	800° C.
1.25	650° C.
2.10	650° C.

In last case 85 per cent. of the carbon changed to temper graphite with six hours' heating.

Wüst has stated this eutectic solidifies at 1,135 deg. C. If carbide separation occurs in the molten iron the dissociated carbon rises as kish† or remains behind in admixture, with a tendency to rise. Very peculiar structures are sometimes met with in cast-iron in which a graphite plate forms the middle of a more or less herring-bone structure, the dark parts of which are finer graphite particles resulting from the decomposition of subsidiary plates of carbide. Obviously coarse graphite, by forming planes of cleavage, diminishes the strength of the mass as a whole. It is nevertheless possible for the separation to be as complete in cases where the flakes are individually smaller, and the less they are the less they will interfere with the continuity of the structure, and tougher and stronger castings will result.

The separation of this graphite has another bearing. Its density is about 2.6, whereas that of the iron at the temperature of its formation varies from 6.8 to 7.2. The increased volume which it occupies does much to counteract shrinkage of the metal, and thus reduce the distortion and the development of internal stresses, in the castings.

In a section of a bar 1 in. square, cast in an iron from which little or no graphite separated, it was observed that the edges chilled and became rigid as the result of being cooled from two sides. The sides were drawn in as the result of the contraction of the crystallising mass and the interlocking of the crystalline rods.

From these considerations the necessity of preventing the formation of coarse graphite in irons which are required to be strong, but of ensuring such a liberation as will prevent the development of excessive internal stresses, is clear.

Combined Carbon.—That portion of the carbide which does not separate as free carbide and decompose to graphite, but is retained by the liquid till it solidifies, behaves exactly as does the carbon in steel, and forms a pearlitic mass which behaves exactly in the same way, so far as it is not interfered with by the presence of other elements. In the case of steel the strength rises progressively with each increment of carbon to a maximum in *fully annealed* steel, corresponding with 0.89 per cent. carbon. Increase of combined carbon causes a similar increase of strength in cast-iron. The rate of increase is less regular owing to the action of other bodies.

FIG. 3.—FLAKES OF CEMENTITE Fe_3C IN BLISTER STEEL.

In the absence of interfering bodies, the stronger, tougher material filling up the interorystalline spaces makes the casting stronger in every way, and even chilled specimens lack that brittleness usually associated with white and chilled iron. Such material can be forged to a considerable extent if little or no coarse graphite has separated. The amount of combined carbon in castings is usually low, and seldom exceeds 0.7 per cent. In the sequel it will be seen that the retention of much combined carbon is only possible in iron of certain composition. An increase in hardness results from the presence of combined carbon, and this increases the difficulty of machining.

Silicon.—The presence of silicides in iron has great influence on its character and behaviour. Baker and Hadfield have shown that in amounts not exceeding 3 per cent. the mechanical properties of iron are not materially altered, being ductile and tough, but the elastic limit and tensile strength are much raised. This applies to pure, almost carbonless, iron, and may be termed the direct effect. Turner's classical work is well known.

In cast-iron the indirect effect is the more important. In a melt containing silicides the separation of the carbide occurs more readily and completely, resulting in the formation of more graphite. High silicon iron contains little or no combined carbon. The silicide appears to have the property of salting out the dissolved or coloidal carbide in the same manner as soap is salted out in soap boiling by means of another soluble body, viz., common salt.

The separation of the combined carbon has a

* Extracted from the Journal of the Manchester College of Technology.

† Probably all the kish met with in the foundry is not due to this cause.

softening effect; the precipitation of graphite reduces the shrinkage and reduces internal stresses. So far as its direct action is effective, and in proportion as it relieves internal stresses, its action must be to increase the strength of the castings; but when the amount present is such that the graphite separated either in increased quantity or in larger flakes tends to produce an equal reduction in strength, the limit of its advantageous application in strong cast-irons has been reached. The amount capable of doing this will vary with the composition of the iron. There is little doubt that substances that lower the melting point and prolong the solidifying stage do in general promote the carbon separation and the growth of coarser graphite, with the necessity of restricting the amount of silicon.

Interesting results were obtained by Hatfield in a series of experiments on iron carbon alloys containing varying proportions of Si. The bars were only 1 in. by $\frac{3}{8}$ in., small and comparatively thin. In such bars precipitation of graphite did not begin till the metal contained 1.43 per cent. of silicon, although the metal contained 3 per cent. of carbon. After this the rate of precipitation rapidly increased. Table II. is part of the table given by this author.

Table II.—*Showing the influence of Silicon on the condition of the Carbon and the maximum stress.*

Combined C.	Graphite	Si.	Max. stress.
0.3	0.28	1.1	16.00 tons
2.7	0.28	1.43	11.22 ,,
2.3	0.65	1.68	11.41 ,,
0.6	2.47	1.72	12.70 ,,
0.55	2.6	1.8	10.7 ,,
0.55	2.68	1.96	14.9 ,,
0.5	2.75	2.19	15.6 ,,

These figures are interesting, indicating, as they do, that when a certain amount of silicide is present the iron is no longer able to retain the carbide in solution.

It is within the Author's knowledge that frequently in dealing with irons low in phosphorus, sulphur, and manganese, very small variations in the silicon, in the neighbourhood of 1 per cent. in large castings, have an enormous influence on the structure, changing it completely from a fine to a coarse grain, or *vice versâ*. It would appear possible that the amount necessary to procure precipitation coincided with a certain concentration of the solution, as frequently occurs in other cases, and that the reason for the smaller amount having the same effect in thicker castings is due to the slower cooling affording greater facilities for diffusion and concentration. When the solution becomes rich enough in silicides, separation and precipitation of the graphite proceed and the grain becomes open. In that case the initial temperature of the mass and the rate of cooling will exert very great influence on the concentration of the silicides by the withdrawal of the iron-rich body, and thus on the grain and strength of the metal, and incidentally on the internal stresses and liability to spontaneous fracture while cooling, or subsequently.

It is probably in this region that many of the vagaries of metal and unexplained causes of fracture must be sought.

In presence of other bodies, such as phosphides, the proportion of silicon necessary to produce carbide saturation and precipitation is less, and hence the completeness of the graphite precipitation and reduction in shrinkage that is secured with such irons.

It has been frequently stated that in some cases irons cast at high temperature have a tendency to be closer and stronger than those cast at a lower temperature. The author's experience has been that the greyness of the iron cast at the lower temperature is of quite a different order. The lack of strength may be ascribed to the fact that before pouring the complete solubility had ceased to exist; the various components of the metal were no longer in perfect solution in each other. The metal may have passed through stages of liquid crystallisation, which are subsequently broken up and cannot be re-formed or resumed at the lower temperature; or some of the products of the final crystallisation may have assumed a colloidal state, and being subsequently mixed up in the pouring, form an emulsion with the remaining fluid, preventing it from following the ordinary process of solidification. It is also certain that in some cases actual separation of solid matter has begun, as in the case of irons throwing up kish.

All cases of kishy irons must not be attributed to the fall in temperature of the metal. There is every probability that in melting in the cupola some of the graphite is not redissolved by the iron, and the metal, as it runs from the cupola, contains free graphite, which rises in the ladle. Such graphite interferes with the development of structure, and gives rise to other difficulties, all of which tend to lower the strength of the casting. For example, they form solid attachments for gas, which may form blow holes or gas films, and probably lead to formation of larger flakes than would otherwise be the case, as by acting as nuclei the rest of the graphite may be deposited on it much in the same way as solids are placed in crystallising liquids to receive the crystals formed. For these reasons probably test-bars and castings run at high temperatures have greater strength than those run at lower temperatures. The author has been often asked what is the correct temperature at which to pour a casting. Obviously it is impossible to state any definite temperature that will apply to all cases, as regard must be paid to so many different factors. Not only the nature of the metal, but the size of the casting, the length of time it will take to pour, the fluid contraction and final shrinkage, among others.

It may be laid down that the most suitable temperature for casting is that which will allow the mould to be completely filled with molten metal, which, when the mould is full, still retains all its constituents in completely fluid solution, and all preparations as regards metal and gates must be made to that end. It is not only unnecessary, but inadvisable, to heat the metal beyond that temperature, since the longer period of setting prolongs the period during which the casting is weak, gives opportunity for the formation of coarser graphite, and the formation and transference of the most fusible eutectic possible in the iron used, with the formation of shrinkholes and local weakening where it has been withdrawn.

With the knowledge of the advantages in strength which result from the rapid cooling of castings, whether by the use of specially designed chilling-plates or by accelerating it in other ways, the author suggests that those castings are weakest in which, from any cause, the separation of iron carbide or graphite precedes the proper development of crystallisation in the mass. In the many examples of strong iron that have come under the author's notice, in which similar materials have yielded widely different results, those giving the higher figures have had this crystalline development, and those giving the lower figures have been confused, or in some cases almost striated when microscopically examined.

Phosphorus.—Phosphide of iron is the most fusible constituent in the iron. It is also the hardest, and is very brittle. In cast-iron it forms with other compounds present a very fusible eutectic, which only solidifies at about 950 deg. C.

The phosphide of iron, Fe_3P, is a highly crystalline body, and when in large excess, itself forms crystals belonging to the monoclinic system—quite distinct from iron whose crystals belong to the cubic system.

Stead has shown that calculated as Fe_3P *pure* iron is capable of retaining in solid solution (*i.e.*, without any new microscopic constituent making its appearance) 1.7 per cent. of phosphorus. This would correspond to nearly 11 per cent. of the phosphide. With larger amounts the phosphide separates as a eutectic, with a melting point of 980 deg. He further found that the presence of carbon caused the separation of the phosphide as a eutectic, as shown in Table III.

Table III.—*Showing the Influence of Carbon on the condition of the Phosphorus in Cast-iron.*

Carbon.	Phosphorus per cent.		
Per cent.	Free as Fe_3P.	In solution.	Total.
0.0	0.0	1.75	1.75
0.125	0.18	1.37	1.55
0.18	0.59	1.18	1.77
0.7	1.00	0.75	1.75
0.8	1.06	0.70	1.76
1.4	1.16	0.60	1.76
2.0	1.18	0.55	1.73
3.5	1.40	0.31	1.71

Institution of British Foundrymen.

COVENTRY BRANCH.

At the second annual meeting of the Coventry Branch, held at the Oddfellows' Hall on April 14, the chair was taken by the retiring president, Mr. F. H. Hurren.

On taking the chair, MR. HURREN said that he had pleasure in announcing the presence of the President of the parent Institution, Mr. Riddell, and on behalf of the Coventry and District Branch he extended to Mr. Riddell a very hearty welcome.

THE HON. SECRETARY (Mr. F. H. N. Lane), in his annual report, stated that the close of their second session found the Branch in a position which was not altogether unsatisfactory. The roll included 28 members, 111 associate members, and 51 associates, making a total of 190. Eight meetings were held during the winter, and these, except at the latter end of the session, were well attended. Three Papers read were by non-members, and six by members, and all were of such a high standard and the interest aroused by them so great that Mr. Broughall had offered a prize of two guineas for the best Paper read before the branch by a member. The Council had recommended Mr. S. Corden's Paper on "General Core-making," for the past session's award. The sum of £119 12s. 6d., representing subscriptions for 1920, had been forwarded to the General Secretary, and £50 received in return. Expenses for the year amounted to £61, and so, with the balance from the preceding year, they were able to carry forward a balance of £5.

The balance-sheet, read by Mr. Lane, showed that a balance of £31 17s. was brought forward from 1919, and there had been received in subscriptions £103 7s., making, with the £50 received from the General Secretary and other items, a total of £186 8s. The balance in hand at the end of 1920 was £4 19s. 1d.

Election of officers.—MR. HURREN said that it was his privilege to propose as President of the branch for the ensuing year Mr. E. Carey Hill. Mr. Hill had been a very active member of the branch and had done much good work. He had attended the meetings of the branch Council regularly, and had acted as delegate to the General Council on every possible occasion.

MR. A. P. SMITH seconded the nomination, and the proposition was carried unanimously. Mr. Hill, on taking the chair, thanked the members for electing him, and said that when he joined the Branch it was not his intention to push himself to the front; he simply wanted, like the rest of them, to learn anything that might be learned from the lectures and the exchange of thought at their meetings. He had done all he could to help things along, and he would continue to do what he could for the welfare of the branch. He hoped that the next session would be a successful one, and it would not be his fault if it was not.

The election of Mr. G. E. Roberts as Senior Vice-President and Mr. C. Dicken as Junior Vice-President was proposed by MR. CAREY HILL. The proposition was seconded by MR. S. CORDEN, and carried unanimously. MR. ROBERTS proposed the re-election, as Hon. Secretary and Treasurer, of Mr. F. H. N. Lane, who had done abundant and efficient work for the Branch. MR. E. WHITWORTH seconded the nomination, and Mr. Lane was unanimously re-elected. For the three vacancies on the Branch Council Messrs. H. Judd, F. G. Smith and J. Sterland were elected. Messrs. F. H. Hurren, G. E. Roberts, and A. Harley were appointed to represent the branch on the General Council.

In asking the President of the Institution to present the Broughall Prize of two guineas for the best Paper read by a member during the session the BRANCH PRESIDENT said that Mr. Broughall intended the award to be an annual one. For the present prize two Papers were selected by the Council, and referred to Mr. Broughall for his final selection.

MR. RIDDELL, in presenting the prize to Mr. S. Corden, said that he was very pleased to know that they had in their Branch men who took so much interest in the development of its work.

It was agreed that the Council should, if possible, arrange for a series of visits to works during the coming summer, also that the winter meetings should again be held on Wednesday evenings at the Oddfellows' Hall.

THE BRANCH PRESIDENT said that the past year's work, for a Branch which had just completed its second year, had been excellently done. The success of the session had been largely due to the sound work put in not only at their meetings, but also outside by their retiring President, Mr. Hurren. On the motion of Mr. Hill, a hearty vote of thanks was passed to Mr. Hurren for his services as President during the past year. Mr. Hurren, in acknowledging the vote of thanks, said that he had one regret, and that was that during his term of office the membership of the branch had fallen off. He had hoped to leave it in a stronger position. All that he had done for the Branch he had done cheerfully, and he hoped that they felt that he had done, as he had tried to do, the best that could be done in the circumstances.

The meeting was followed by a smoking concert, and during the short interval for speeches the PRESIDENT of the Institution proposed as a toast "The Coventry Branch."

MR. RIDDELL said that he was delighted to hear of the progress they had made, and he was not surprised. As President of the Institution a very large portion of the support he received at the Council meetings came from the delegates of the Coventry Branch. Their enthusiasm was shown by their readiness to attend those meetings, although it meant their travelling all over the country. As President he was glad to have the opportunity of expressing his appreciation of what the Coventry Branch had done for the Institution as a whole. He was very glad to have had the pleasure of presenting the cheque to Mr. Corden, and to find that there were gentlemen like Mr. Broughall so anxious to encourage the propaganda. They in Scotland might have been the first with that sort of thing, but Coventry had forestalled them. They had a member who was proposing to give a gold and a silver medal every year for competition among members of the Scotland and the Newcastle Branches, of both of which the donor was a member. He hoped that the example set by the Coventry Branch would be followed by other Branches, and also with regard to the Institution generally. The Institution, with its various Branches, he regarded as one of the most valuable educational agencies in the country. To his mind the Institution was built on the right lines for educational purposes. A man came into that Institution of his own free will; in fact, he was wise before he came in or he would not want to do so, and when he came in he had the opportunity of continually gaining in wisdom. Foundrymen could gain wisdom by their experience and by thinking over the troubles they met with in the foundry. They thus got a desire for more knowledge, and were wise enough to know that they could get help by attending those meetings. He had a feeling that the foundrymen's meetings were going to do good to the country as a whole. Such meetings induced men to get out of the rut, and taught them that their work, instead of being mere drudgery and time-serving, was both a duty and a privilege. With regard to the scientific side of the foundry, there had been much less work done in the way of research with cast iron than with other materials. But a certain amount of research had already taken place, and in that work their Institution had got to help. It was gratifying to note that it was the Institution of British Foundrymen that had been the means of getting established the British Cast Iron Research Association, which would soon be commencing its work. He was sure that that Association would do a great deal to develop the scientific side of foundry work, and in so doing would raise the status of their trade. In the past the foundry business had been very much despised. He was astonished to see recently in a Glasgow newspaper an advertisement for a foreman to look after a foundry in which eight cupolas had been installed, and to notice that the man was required to know what was going on inside the cupola as well as what was going on outside it. That showed a great advance on the former ideas of employers,

though he was afraid they were still asking for something that they could not get.

Mr. E. Carey Hill, on behalf of the Branch and himself, replied to the toast, and thanked Mr. Riddell for visiting the Coventry Branch.

SHEFFIELD BRANCH.

Discussion on Mr. J. B. Hoblyn's Paper on the Foundry and the Automobile Industry.*

The Chairman (Commander Jackson, R.N.) said the data Mr. Hoblyn has shown were very remarkable. Many inspectors had told him (the Chairman) of the difficulties with malleable castings, the greatest of which seemed to be reliability.

Mr. Darley said he agreed with the lecturer that the designer should discuss differences with the foundryman, and also that the former should have a practical knowledge of foundry work. The small line of work with which Mr. Hoblyn dealt had very little relation to the work turned out in Sheffield. With regard to Mr. Hoblyn's remarks on silicon in steel castings, he (the speaker) thought that the foundry of which he then spoke must have been a third-rate one. In the foundry in which he worked they specialised in steel castings, and their silicon never exceeded 0.35 per cent. All steel castings should be annealed. In the automobile industry it was practically impossible to make a sound steel casting where it was necessary to fit a thick part through thin steel. With regard to the workmanship and the samples of it which had been illustrated on the screen, he agreed that a good deal of the twisting was due to carelessness either in the annealing or in the closing of the moulds. With regard to alloy steel, they could get a 3 per cent. nickel steel oil treated and properly annealed which would give 20 per cent. elongation, 180 deg. bend, and 50 to 55 tons tensile.

Mr. Holland said after having a fair amount of experience in motor cylinder work, he wondered if the lecturer realised the difficulties of the foundry. One automobile firm started to produce their own cylinders, and at the end of three months they were not successful in casting one single good casting. To test the cylinder in the rough was quite easy, and it would save considerable expense, although he admitted some would leak after the surface was removed. In the works referred to he had seen nine out of twelve rejected on this rough test. He (the speaker) put it to the management that they were not using the right mixing of metal. He submitted a mixing to the men in charge, with the result that eleven out of twelve were able to withstand the first test, and nine passed the final test, but even then they were not prepared to purchase the special mixing.

Mr. J. Ferdinand Kayser, Assoc.Met., said that he was most surprised at the lecturer suggesting that any foundrymen would send out castings such as those he had shown on the screen. Perhaps one such casting might unintentionally slip through, but he was quite sure that any foundry would at once replace any such casting free of charge, and handsomely apologise for their carelessness.

Mr. Wilkinson, referring to the lecturer's remarks that foundrymen preferred straight lines and large masses of metal, said he did not agree. What they wanted was an even metal. With regard to the cylinder, they only saw a section of it on the screen, but there did not appear to be any provision on it for getting the gas away from the cores. The question of suspending cores was very often overlooked by the draughtsman. He was quite sure the foundries in Sheffield were not prepared to take the class of work which had been shown to them by Mr. Hoblyn. Before they would do so there would have to be a great deal more variation in design than now.

Mr. Haden said he would like to ask if it was the practice of the automobile engineers when asking for quotations to send out drawings or let the foundrymen have the patterns. If a moulder saw the pattern, he could ask for a modification of it. There was no doubt that in motor cylinders they had got to a very fine pitch, but unless the foundry was absolutely well equipped a good casting could not be made. In Sheffield they were not laid out to make motor cylinders. With regard to the faults in the back axles which had been mentioned, he did not think they were always the fault of the foundryman. Even when they were made out of forged steel they broke.

Mr. Dawson said there was a great deal in what Mr. Hoblyn had said. He had given them a very complete exposition of the feelings and faults on all sides, though what he had to say about the faults of foundrymen was rather one-sided so far as Sheffield was concerned. With regard to the heat-treatment of steel castings, there is no doubt such treatment could be, and was being, applied to-day by scientific foundrymen.

*See page 337 *et seq.*

The Author's Reply.

Mr. Hoblyn said he was glad to hear that Mr. Darley agreed with him on the necessity of more co-operation between the designer and the foundryman, and often he (Mr. Hoblyn) had to act as a referee between them; but he generally found that castings could be made without sacrificing beauty, and at the same time satisfying the foundryman when slight adjustments were made in the patterns.

He had not so far met with a 3 per cent. nickel steel heat-treated automobile casting, and he was not aware that foundries as a general thing made such castings. Mr. Darley had stated that recently he had obtained from nickel steel castings 59 tons maximum stress, 180 deg. bend and 18 per cent. elongation, but this was not on automobile castings.

With reference to the suggestion that the automobile industry ought to make its own cylinders, he thought that this was a bad suggestion, because the foundryman, after years of experience, should be in a far better position than the automobile firms to do this work. Further, if automobile firms took up such work it would inevitably side-track some of the best brains to the consideration of work that was the work of the foundryman. They in the automobile industry wanted the foundries to help them, and he did not agree that the automobile engineer was not prepared to pay for good sound castings. The industry would pay, and would be glad to pay, for good sound castings of good material. It was obviously useless for automobile firms to assemble unsound castings, and, no matter how cheap these were, they would be absolutely useless for the trade.

Mr. Hoblyn* submitted that the automobile engineer had a right to expect that when a man undertook a particular job it was his duty to produce the work according to quotations and specifications, and in many instances this was not done.

Mr. Kayser thought that Mr. Hoblyn had been a bit unfair, but he wished to assure Mr. Kayser that he had no desire to be so. He quite agreed that many good castings were to be had; but the samples he had shown were some that had come under his own experience in the trade; they were not isolated samples, but in some instances represented large batches of rejected work. He knew full well that the reputation of the English motor-car had in the past been built upon castings, and the foundry had helped materially; but it did seem at the present time that what would not have been considered difficult work in pre-war days was now considered difficult by the foundryman.

With regard to the fins in castings, he had seen many instances where these went right across, and circulation of the water was stopped. This was, in the main, due to the fact that careless work had been shown in joining the cores, or in making the joining in the wrong place.

Certainly one could foresee in the future many parts which might be made of castings, particularly for small cars; but before this could be done very keen attention must be given to the production of the sound thin sections.

On the proposition of Mr. Shaw, seconded by Mr. Bagshaw, a vote of thanks to the lecturer was passed.

Discussion on Mr. W. Rawlinson's Paper on Modern Cupola Practice.

The Chairman (Mr. J. R. Hyde) said, in connection with the vexed question of blast-pressure

*See page 381 *et seq.*

and fans *versus* blowers his (the Chairman's) father was very much in favour of the blower, but after seven years he persuaded him to try a fan. It was motor-driven, and the first thing they did was to burn it out in the first ten minutes, due to the large volume of air that could pass through stock in a clean cupola. Again, on the weight of the charges and the way metal was melted, our ideas had been revolutionised during the last 20 years. He would like to know where to obtain coke containing 0.7 per cent. of sulphur. The majority of cokes was not less than 14 per cent. of ash, and sulphur was up to 1.5 per cent. He was told that all the dirty coal at the collieries to-day was sent to the coke-ovens, and the product was dumped on the foundries. They seemed to think anything was good enough for the foundrymen. With reference to the question of the mechanical charging of the cupolas, that was a subject upon which he had been giving a good deal of thought, because it was important in those days, when labour was so expensive. Some years ago he had used an inclined hoist, and the original idea was to tip the charge straight into the cupola, which was only 30 in. in diameter, and he found the material piled up on one side. The solution of that matter, he thought, lay along the line of the grab bucket, though he had had dreams of charging with a magnet. The only objection he saw was that if pig in big quantities were dropped in from a height the coke suffered.

MR. SHAW said, with reference to the research carried out by the American Bureau of Mines, it should be remembered that the position of the inverted cone in relation to the tuyeres would be altered when working with a high or low blast-pressure. That was, the dimension between the tuyeres and the base of inverted cone, given as 20 in. only, held good at the 14-oz. pressure used. He (Mr. Shaw) thought the investigation would have been more useful if the usual charges of iron had been used, instead of filling the cupola only with coke. With regard to the weight of the charges to be used, he thought Moldenke's method of laying a 4-in. layer of coke of the diameter of the cupola, and using this as the standard coke charge, was a better method than that of Mr. Rawlinson's. The iron charge was based on this weight. For instance, it was found that a 4-in. layer of coke in a 42-in. cupola was about 2 cwt. Then the iron charge, if working to a ratio of 1 to 10, would be 20 cwt. of iron. Four inches of coke had been found to be the least practical amount, and so reduced the iron charge to the least weight at the ratio you wished to use. This method gave very regular working. He agreed with Mr. Rawlinson that the charges should be weighed. Nothing led to coke saving more than this. No man could guess a ton correctly when dealing with heavy and light scrap. He (Mr. Shaw) had found when having the iron weighed secretly, at the end of a day's blow, that the charges had been as much as 20 per cent. out. Under these conditions it was quite impossible to cut the coke charges to the minimum. Coming to the self-charging devices, he could confirm Mr. Rawlinson's statement that the Continent was ahead in this direction, one seen at Messrs. Thysen's being entirely automatic. Perhaps the latest was one that had the cupola shell made at the charging hole to receive a bogie with a drop bottom. The entire charge was dropped into its right position, the bogey being removed, to be replaced by a full one. He (Mr. Shaw) was pleased that Mr. Rawlinson had made no extravagant claims of low melting ratios for any of the cupolas shown. In fact, he approximated to about the figures given by Mr. Yates in the report on Fuel Economy before the Iron and Steel Institute. This was in direct contrast to a statement made recently in THE FOUNDRY TRADE JOURNAL, in reference to which all he could say was that from the returns sent in to the Minister of Munitions on cupola coke consumption, no cupola of this particular type did better than 1 in 10, including the bed, on a full day's work. That it was possible to melt one or two charges may be granted, if a very hot, high bed charge is used, and the subsequent two charges or so are made up of light scrap and small portions of pig.

MR. RAWLINSON, in reply, said he quite agreed with the Chairman that they were not getting a good class of coke. That was very largely due to themselves for not insisting upon a better quality. His figure of 7 per cent. ash did possibly represent to-day's practice. They suffered to-day from indifferent bye-product coke. To have continuous melting, they must have suitable proportioning of coke to metal. They should not have very big charges. With regard to mechanical charging, it was only done so far with fairly large cupolas, say, 5 ft. diameter inside lining and upwards. On the Continent the practice was very much ahead of that in this country, and they would have to tackle that problem in the very near future if they were going to cut down melting costs. The arrangement mentioned by Mr. Shaw was a good one, and it would be quite practical. He had never experienced any difficulty with reference to the point about the damage to the coke. Coke would stand more than most people thought. Indeed, the surprise to him was the great height of the charging point with mechanical chargers in Belgium. In reply to Mr. Shaw, he differed with him as to the results obtained by the Bureau of Mines in the U.S.A. not being analogous with the usual practice in foundry work. He (the lecturer) had not been able to carry out research to the same extent as those in the States, because of the expense incurred, but years ago he made a series of tests, and whilst the data obtained were not as comprehensive as those he had shown, they indicated very much the same principles. The purely scientific findings in these researches corresponded very nearly with actual practical experience. If they could get a perfectly level sandwich of fuel of the right thickness when they were going to get ideal melting conditions, it mattered very little whether this was expressed in terms of thickness or weight. The best coke ratio he had done was rather better than 10 to 1, and that included the bed. In conclusion, Mr. Rawlinson expressed the hope that every foundryman in the country should try to get the fuel consumption down to the figure which he had seen recently mentioned, namely, $1\frac{3}{4}$ to $\frac{5}{8}$ cwt. per ton. If that were done there would be a great saving of fuel in the country. Fuel economy was entirely a matter of using an efficient cupola, and managing it properly.

A vote of thanks to the lecturer closed the meeting.

MANUFACTURE OF DEXTRINE IN JAPAN.—The manufacture of dextrine in Japan is (according to *Chemical and Metallurgical Engineering*) a comparatively new industry, having been organised on a commercial scale only during the past three or four years. It is principally used in the textile industry. Japanese dextrine is exported chiefly to Great Britain, small quantities going to the United States, amounting in 1919 to 132,160 lbs., valued at $11,945. The manufacturers at present are not making a profit, and, unless living costs and wages are reduced, bringing a reduction in the cost of materials and manufacturing, it is possible that the industry will not survive the depression. The cost of production per 100 lbs. is approximately $5.53, while the price of dextrine in the markets of Osaka and Kobe is around $5.13 per 100 lbs. for white and $5.58 for the yellow. There are three small dextrine factories in Japan—one in Osaka, one in Tokyo, and one in Kyushu—and the total output for all Japan is about 300 tons per month.

DUPLEX ELECTRIC STEEL-MAKING IN FRANCE.—The Société des Acieries du Nord et de l'Est, which now controls the Basse-Loire, Pont à Vendin, Espérance and Nord et Lorraine, is now working two electric steelworks, these being at Neuenkirchin (Sarre), formerly in the hands of Stumm Brothers, and Trignac (Loire-Inferieure). In this latter works liquid basic Bessemer steel will be taken as raw material for the electric furnace.

MR. G. STRACHAN, secretary and director, was entertained by the directors of the Fairfield Shipbuilding and Engineering Company, Limited, Govan, along with the officials and head foremen, at dinner recently, on his completion of 50 years in the service of the firm. Sir Alexander M. Kennedy, the managing director, presided, and was accompanied by Rear-Admiral Sir Douglas Brownrigg, Bart., Mr. R. Traill, and Mr. W. O. Workman, directors.

Trade Talk.

The clerks in the Dowlais offices of Guest, Keen & Nettlefolds, Ltd., received notices which expired on Thursday last.

By a hydro-electric power scheme, the mills of Sir Henry Ballantyre & Sons, Limited, near the River Tweed, are now wholly independent of coal fuel.

Before the Sheffield Society of Metallurgists and Metallurgical Chemists, on Tuesday, Mr. J. Neill Greenwood gave a paper on the internal stresses in tool steel.

A number of shipbuilding firms on the Tyne have decided to reduce the working days to four per week. In addition one yard will only work six hours on the four days.

Wear members of the National Amalgamated Union of Labour have by a large majority agreed to accept the reduction in wages proposed by the shipbuilding employers.

The Finnish Geological Commission reports that the recently-discovered field of iron ore, in the district of Kittila, covers 365,000 square metres and contains about 100,000,000 tons of ore.

The Administration of the Chilian State Railways is calling for tenders for the supply of tyres, axles, and springs to a value of about £75,000. Tenders are to be presented by June 7 next.

Belfast shipbuilding employés have accepted wage reductions by two instalments of 3s. per week for time workers, and 7½ per cent. on piece rates, one to come into force on May 1, and the other in July.

The meeting between a deputation from the National Union of Manufacturers and the Minister of Labour, which was postponed from April 6 owing to the industrial crisis, has now been fixed for Friday, May 6, at 3 p.m.

In order to secure the re-opening of the furnaces, the blastfurnacemen and ironstone quarry workers in Northamptonshire, numbering about 5,000, have agreed to a reduction in wages of from 10s. to 12s. per week.

The members of the South Wales Institute of Engineers met at the Institution, Cardiff, on Thursday last, under the presidency of Mr. W. Forster Brown, when Mr. D. Bowen read his Paper on "The Law of Support."

It is announced by the London representative of the National Trust Company, Limited, head office, Toronto, that the company has been appointed transfer agent in Toronto and Montreal for the newly-formed British Empire Steel Corporation.

Messrs. J. Samuel White & Company, East Cowes, Isle of Wight, have launched the cargo steamer "Auvergne," which they have built to the order of Messrs. Delmas, Freres & Vielieux, of La Rochelle. The vessel is 3,229 tons (dead weight).

The Electricity Commissioners who recently held an inquiry at Llandudno have reported against the Chester scheme for supplying Chester and North Wales with electricity. Subject to certain conditions the North Wales power scheme is adopted.

Professor Desch, head of the Faculty of Metallurgy at the Sheffield University, delivered the opening lecture of the new session on April 22. The present course deals with the principles underlying the testing of metals, especially the newer types.

Mr. Corbould, manager of the Mount Elliot Company of Queensland, is leaving Brisbane for England, where he intends raising one million pounds sterling to enable the company to erect works at Cloncurry, Queensland, to treat one thousand tons of copper ore daily.

The London School of Economics and Political Science, Clare Market, Kingsway, W.C.2, announces a course of nine lectures on "Problems of Modern Industry." These are to be delivered by Sir William H. Beveridge, K.C.B., M.A., B.C.L., on Tuesdays, at 6 p.m.

Mr. Balfour, Sir J. J. Thomson, and Sir Robert Hadfield were among the speakers at the Institute of Civil Engineers, Westminster, on the occasion of the inauguration of a new Institute of Physics. Sir Richard Glazebrook presided. There was a large attendance.

At the annual general meeting of the Institution of Mining and Metallurgy, held recently, at Burlington House, W., Mr. F. W. Harbord, C.B.E., delivered his presidential address, which dealt mainly with the general effects of the war on our metallurgical and kindred industries.

The first passenger and cargo vessel built to the order of the Australian Commonwealth, was launched on the 23rd ult., from the yard of Messrs. Vickers, Ltd., Barrow-in-Furness, and was named "Moreton Bay" by Mrs. Storey, wife of the Hon. John Storey, Premier of New South Wales.

In consequence of the illness of Mr. Justice Sargant, the chairman of the Royal Commission on Awards to Inventors, it has been found necessary to postpone the hearings of claims. A further notification will be issued as soon as it is possible to fix a date for the hearing.

According to latest advices the United States pig-iron production for March was 1,595,500 tons, compared with 1,937,300 tons in February, and 3,375,900 tons in March, 1920. The daily production for March was 51,468 tons, compared with 69,187 tons last month, and 108,900 in March, 1920.

At the second annual meeting of the Liverpool Sub-Centre of the Institution of Electrical Engineers, the officers and new members of the committee for the session 1921-22 were elected. The membership of this section of the I.E.E. is now 387, being an increase during the year of 75.

Lord Joicey, presiding at the Newcastle Chamber of Commerce, said industries could only be maintained by a reduction in costs, and workmen should realise the situation. Production per man had gone down. In various industries there seemed to be a "ca' canny" microbe that had affected workmen.

The West Wales copper works owners are taking steps with the object of securing a reduction in the wages of their employés. The scheme submitted by them is, it is stated, the establishment of a sliding scale with a base rate, towards which the present wages will sink as the cost of living decreases.

A conference of engineers for the North-Western Division was held at Barrow, on the 23rd ult., delegates attending from Preston, Blackpool, Fleetwood, Southport, Kendal, Lancaster, and West Cumberland. Mr. W. Dowker, of Barrow, was elected chairman for the next twelve months, in place of Mr. J. Summer, of Preston, resigned.

The Rise Carr rolling mills of Darlington have been shut down owing to the coal strike. A deputation, representing 800 employés thrown out of work, subsequently asked the directors to pay them £1 per week until work is resumed, when they would repay the money by weekly instalments. The directors agreed to adopt this course.

Male piece workers in the nut and bolt trade in Birmingham and the Black Country have accepted a reduction of 10 per cent. in piece rates, the new rates dating from Wednesday, April 6, or Thursday, April 7, according to the pay day in the respective establishments. There has been no change in the day rates of male workers.

The 40th annual dinner of the students of the Institution of Civil Engineers was held last week at the Trocadero Restaurant. Mr. F. W. S. Hawtayne (chairman of the London Students' Committee) presided. Mr. J. A. Brodie (President of the Institution), responding to the toast of "The Institution," said that it had now over 9,000 members and student members numbered about 700.

Subscriptions are invited in respect of an issue of £750,000 8 per cent. first mortgage debenture stock of Sheffield Steel Products, Limited. The stock will be issued at the price of 95 per cent., and will be repayable at 105 per cent. on or before December 31, 1940, by means of a Cumulative Sinking Fund, commencing 1922, by equal annual drawings. The stock will be limited to a total issue of £850,000. The list of applications closes on or before May 9.

By a majority, the Federal Trade Commission, U.S.A., in the matter known as the Pittsburg basing case, has declared that it has reason to believe that the United States Steel Corporation and its subsidiary companies have been using unfair methods in competition, in violation of the statutes of the Corporation. The Commission lodged a formal complaint against the Corporation, which it has given 30 days to answer. The issue will then be joined and the matter tried on its merits.

The Welsh Engineers and Founders' Association announce that, as the result of negotiations with Trade Unions concerned, the following reductions in wages will operate on and from April 25, 1921:—Pattern-makers, £5 12s. 6d., reduced to £5 2s. 3d.; moulders, £5 10s., reduced to £5; cupola men, £4 5s. 9d., reduced to £3 19s. 9½d.; casting dressers, £4 10s., reduced to £4 3s. 4d.; labourers, £4, reduced to £3 15s. These rates represent the total earnings for a 47-hour week. The war bonus was consolidated into these rates on April 3, 1920.

A number of metallurgists are said to have investigated the effect of a new alloy called "burrowlite" on the physical properties of steel. The alloy was discovered by the late Dr. L. P. Burrows, a mining engineer, while experimenting with nickel ores. It is claimed for it that it imparts to the steel toughness, great density, a high elastic limit, and ultimate tensile strength, either high or low elongation as desired, and machinability even when showing a Brinell number of 360 or more. The inventor brought his discovery to the attention of Mr. Daniels, Secretary of the U.S. Navy, and, as a result of investigations, the alloy was used by the Navy Department during the war.

Gazette.

MESSRS. LAWRENCE WHEATLEY and Thomas Holmes, trading as Ibbotson & Wheatley, Furnival Street, Sheffield, engineers, have dissolved partnership.

CRAWFORD FOUNDRY COMPANY, LIMITED, London, E.C.—Mr. L. J. R. King, 88, 89, and 90, Chancery Lane, W.C., I.A., has been appointed receiver, April 11.

THE LINGTON ENGINEERING COMPANY, LIMITED, is in course of voluntary liquidation. Claims to Mr. E. H. Hawkins, 4, Charterhouse Square, E.C., liquidator, by May 9.

AGER & HAYWOOD ENGINEERING COMPANY, LIMITED —It has been resolved that the company be wound up voluntarily. Mr. J. D. Kerr, 5, Waterloo Street, Birmingham, I.A., is appointed liquidator.

MESSRS. SIDNEY HERBERT PLATT and Gilbert Harvey, trading as Platt Bros. & Company, Corporation Street, Walsall, malleable ironfounders and shipping agents, have dissolved partnership. Debts by Mr. G. Harvey, who continues the business.

THE partnership heretofore subsisting between Frederick John Guy Beech and George Frederick Sershall, trading as Beech & Sershall, Olympic Works, Miller Street, Birmingham, metal ware manufacturers, has been dissolved. Debts by Mr. F. J. G. Beech.

THE partnership heretofore subsisting between Frederick Arthur Cromwell Maurice, Horace Frederick Maurice, and William Horton, trading as F. A. C. Maurice, Son & Horton, Paragon Works, Blythe Street, Birmingham, brass founders, has been dissolved. Debts by Mr. F. A. C. Maurice, who continues the business.

Personal.

THE late Mr. Charles Hahlo, Stoneleigh, North Park Road, Bradford, machine maker and exporter, left £6,495.

THE late Mr. R. S. Dower, senior partner in Messrs. George Deepledge & Company, iron and steel merchants, Leeds, left £11,889 gross.

MR. J. B. RUDKIN, 21-23, Shaftesbury Avenue, London, W.C.2, has been appointed British agent of the Sprecher & Schuh Company, electrical engineers, Aarau, Switzerland.

THE late Mr. John Smith, Ryecroft House, Rochdale Road, Heywood, Lancs., senior member of William Smith & Brothers, Limited, loom makers and machinists, Sun Iron Works, Heywood, left £99,756.

THE late Mr. C. A. Barrett, of Montagu Mansions, Portman Square, W., late of R. Barrett & Son, Limited, and the Hoffman Manufacturing Company, Limited, brass and iron founders, left £413,952.

IT is announced that Mr. C. A. Roberts, who has been associated with the Great Western Railway for more than fifty years, and has acted as chief goods manager since 1912, will retire shortly from active service.

MR. R. MONROE, the general manager of the Barry Graving Dock and Engineering Company, Limited, who is exceedingly ill, has been succeeded in the position by Mr. A. Cox, of the Channel Dry Docks and Pontoon Company, Limited, Barry.

MR. H. ARMSTRONG has resigned his position with the Cargo Fleet Iron Company, Limited, and from May 2 will act as London representative of the Lanarkshire Steel Company, Limited, Motherwell, whose offices are in London House, New London Street, E.C.

MR. HERBERT SOUTHERN, who is leaving the firm of Messrs. Steel, Peech & Tozer, Limited, Rotherham, to take up a position in Sheffield, has been presented with a solid gold hunter watch, suitably engraved, to which expression of respect many of his colleagues had contributed.

MR. A. B. CARTLAND, 3, Creechurch Lane, Leadenhall Street, London, E.C.3, has been appointed agent for London and South Counties for Wm. Whittaker (Burnley), Limited, boiler furnace manufacturers, and the "Premier" Appliances Company, Limited, makers of boiler expansion joints, etc.

Company News.

Brush Electrical Engineering Company, Limited. — The net profits for the past year were £191,096, and £74,726 was brought forward. A dividend of 15 per cent. is proposed, adding £13,000 in the depreciation account, and £53,377 to the reserve, writing £15,576 off issue expenses, and carrying forward £143,268 subject to taxes.

Andrew Knowles & Sons, Limited.—On accounts to March 31 it is proposed to pay a further dividend of 4 per cent., less tax, making 7 per cent. for thirteen months.

James Cartland & Son, Limited. — Profit, £9,861; brought forward, £7,219; final preference dividend, 5 per cent. per annum for six months ended December 31; ordinary dividend, 7½ per cent.; carry forward, £11,815.

John Collier & Company (electrical engineers), Limited.—Capital £20,000 in £1 shares (12,000 "A" and 8,000 "B."). Registered office: 29, King Street, Manchester.

Dennis & Webb, Limited, Engineers. — Capital £8,000 in £1 shares. Registered office: 42 and 43, Little Britain, E.C.

R. Elliott & Company, Limited, machine and small tool manufacturers, and dealers.—Capital £5,000 in £1 shares. Registered office: 226, Bishopsgate, E.C.

Lancashire Wagon, Limited.—Profit for half-year ended March 31, 1921, was £2,537, plus £1,254 brought in, making £3,791. Directors recommend dividend at rate of 10 per cent. per annum, free of tax, on ordinary shares, placing to reserve, £1,000, carrying forward £1,115

P. and W. Maclellan, Limited.—Ordinary dividend, 6 per cent. actual, making 13 per cent. for year; depreciation, £10,000; reserve, £15,000; carried forward, £29,578.

Manganese Bronze & Brass Company, Limited. — Profit, £42,446; brought forward, £9,949; ordinary dividend, 7½ per cent.; writing off issue expenses, £5,072; ditto removal expenses, £5,000; carry forward, £13,940.

Marley Engineering Company, Limited. — Capital £2,000 in £1 shares (580 preference), to take over the business carried on by C. P. Marrison and L. Wheatley, as the Marley Engineering Company, concrete, mechanical, and general engineers, etc. Permanent directors: C. P. Morrison and L. Wheatley. Registered office: Hope Works, Furnival Street, Sheffield.

Park Gate Iron & Steel Company, Limited.—Final dividend recommended of 1s. per share, free of tax, making 1s. 6d. per share for year ended March 31.

Sanderson Brothers & Newbould, Limited.—Profit, £27,796; brought forward, £9,049; preference dividend, 5 per cent. for year, £2,248; ordinary dividend, 6 per cent. (less tax); reserve, £10,500; carried forward, £8,708.

Sphere Engineering Company, Limited. — Capital £2,000 in £1 shares. Engineers, mill-wrights, founders, smiths, pattern makers, etc. Registered office: 56, Hermitage Street, Sheffield.

Steel Export Company, Limited.—Capital £20,000 in £1 shares. To carry on the business of merchants, exporters, and importers of and dealers in iron, steel and other metals, etc

A. and E. Welding Company, Limited. — Capital £2,000 in £5 shares, to take over the business carried on by E. C. Coke at Ashford, Kent, as the A. and E. Welding Company. Registered office: 7, Bank Street, Ashford, Kent.

J. & G. Wells, Limited.—Final dividend of 3 per cent., free of tax, on ordinary.

Midland Iron Company, Limited.—Interim dividend of 1s. per share, free of tax, on ordinary, also usual dividend on preference.

United States Steel Corporation. — Quarterly dividend of 1¾ per cent. on preferred stock, and quarterly dividend of 1¼ per cent. on common stock; surplus (three months), $2,816,905.

Western Wagon & Property, Limited.—Accounts for 1920 show an available balance of £22,780, which, with £1,064 brought forward, gives a total net revenue of £23,845. Interest on debentures, deposits and bankers' interest and interim dividend absorbed £18,005. Final dividend recommended at rate of 10 per cent. per annum (less tax), making 10 per cent. for year, carrying forward £941

Deaths.

MR. B. BLOUNT, the well-known electro-chemist, who was previously in partnership with Mr. R. H. Stanger, as Stanger & Blount, died recently. Latterly the deceased gentleman practised on his own account.

MR. A. WALL, manager for Messrs. Stewarts and Lloyds at Kimberley, died on the 25th ult. He arrived in England from South Africa on Thursday of last week, and was taken ill on the following day.

SIR FRANK BOWDEN, BART., the founder and proprietor, with his son, of the Raleigh Cycle Company, Limited, died on the 25th ult. at his residence, Bestwood Lodge, near Nottingham, aged 73. He was also director and principal owner of Sturmey-Archer Gears, Limited.

MR. F. W. SEAMAN, of Ecclesall, who died on the 22nd ult., in his 77th year, was for a long period general manager of the works of Edgar Allen & Company, Limited. He afterwards became a partner in the firm of Messrs. Francis Hobson, Seaman & Company, now styled Messrs. Hobson, Houghton & Company. He retired from active business about 23 years ago.

XUM

IRON AND STEEL MARKETS.

Pig-Iron.

The collapse of the coal negotiations at the week-end has had a further depressing effect upon iron markets everywhere, and business in all markets is now practically suspended until some solution of the fuel difficulty can be discovered. The situation in the pig-iron trade is unquestionably more critical at present than has ever been recorded, perhaps in its history, demand both on home and export account having dwindled to vanishing point, and with the sole exception of small purchases by foundries there is absolutely nothing moving in the market. On Tees-side, there is now practically no No. 3 Cleveland pig left, makers' stocks having become exhausted, and the only firm in operation smelting this quality is quoting 10s. above the reduced rate fixed a few weeks back. Though not generally understood at the time, the quotations then officially intimated applied in a minimum and not a maximum sense. Stocks of the lower quality pig have, however, accumulated to a large extent, but in the absence of home demand for forge, mottled and white iron, which are also a drug in the export trade, only a very limited business is passing. Consumers had quite expected that by this time something like a free market would be established in forge iron, but, so far, no move in this direction has been made by makers, who will find some difficulty in disposing of stocks at the current rate of 117s. 6d. per ton. In the meantime the official pig-iron quotations are unchanged, both for home and export, as follows :—No. 1, 125s.; No. 3, G.M.B., 120s.; No. 4, foundry, 119s.; No. 4, forge and mottled, 117s. 6d.; white, 115s. Shipments of pig-iron from Tees-side ports for the past month will show a very disappointing result, although not comparing unfavourably with the total for the previous month. So far, there has been no change in the conditions of Scottish pig-iron, and probably but for foundry requirements, which for lack of fuel cannot long continue, the trade would be absolutely at a standstill. Meanwhile, all the furnaces north of the Tweed are out of blast, and it must necessarily be a considerable time before smelting operations are again active. Similar conditions prevail in South Staffordshire, the Midlands, and Lancashire, where market movements are absolutely demoralised by the fuel famine.

The hematite market is lifeless, the complete collapse of the steel industry having entirely eliminated demand in all markets. To add to the difficulties of the position, consumers decline altogether to pay 180s. for mixed numbers, when this metal is offered by makers for export at about 155s. per ton f.o.b. This has resulted in makers reducing the price of E.C. mixed numbers to 160s. for the home trade.

Steel.

Each succeeding week of the calamitous industrial upheaval in the coal industry marks a further decline in steel production, more Sheffield works and departments having closed down since last reported. Fuel supplies in the district are now all but exhausted, and only those works equipped with electric power are enabled to partially continue operations, the lighter branches running on half-time, principally on orders for various kinds of tools and cutlery, and also small castings, principally for builders. Unfortunately the position is complicated by the almost complete cessation of the stream of foreign inquiries customarily expected at this season of the year, and it appears by no means certain that a definite settlement of the miners' dispute would greatly improve the situation in the steel trade. It is, at all events, generally admitted that a considerable percentage of makers are only provided with a few orders at present with which a start could be made if work were at once resumed, both the crucible and heavy steel branches being almost barren of fresh specifications, while the state of foreign exchanges precludes hopes of any immediate improvement as far as European markets are concerned, the States also suffering from a similar reaction in trade activity. The current high prices of special quality steels represent almost prohibitive figures in most of the world's markets, and only odd parcels of these materials are going for export. As indicating the adverse effect of the strike upon Midland steel makers, it is reported that they have already lost £8 per ton on certain steel billet contracts, being unable to use up the material bought. Belgian salesmen are offering billets at £8 to £10 delivered in the Midlands. The shortage of fuel supplies is having a serious effect upon the Scottish steel trade, a Motherwell firm, employing nearly 2,000 men, having closed down, and another firm in the same district having 160 men unemployed and over 400 working short time. In the North of England the iron and steel industry is stagnant. At Hartlepool four large firms, employing approximately 3,000 men, have closed down, while there are 1,900 men on the registers at Thornaby.

Finished Iron.

Pending some solution of the present fuel supplies difficulty, business in finished iron is non-existent, and must certainly remain in that position until peace in the industrial world can be restored. The deadlock reached last week in the negotiations between the miners and coalmasters gives little encouragement of an early settlement of the question, and meantime buyers and producers of finished material are completely reduced to inaction, with only faint prospects of an early re-start in manufacturing operations. Makers of marked bars have as yet made no move towards a reduction of current prices, now regarded as inevitable when conditions are again normal, while in the case of Staffordshire crown qualities, although no official announcement has been made, it is generally accepted that about £19 represents the full market value of this class of iron product. Gas strip is also a quiet market, with prices fairly steady round about £22, regarded as quite disproportionate while crown bars are quoted on the above basis. The Lancashire market is quite stagnant for all kinds of finished iron, and the expected revision of prices is in abeyance. The general belief seems to be that this downward movement must be resumed so soon as normal times return, in order to bring the prices into some sort of workable relation with the Continental prices. The imports of iron, steel, etc., at Hull from abroad throughout the past week were:—Iron: Pig, 80 tons (W. Mathwin & Company), 10 tons (Wilson's & N.E.R. Company), bars, etc., 222 tons (Cox & Danks), 23 tons (Hull and Netherlands S.S. Company), 50 tons (Wilson's & N.E.R. Company). Steel: Sheets, bars, etc., 207 tons (Cox & Danks), 280 tons (Wilson's & N.E.R. Company), 32 tons (Gerhard & Hey), 6 tons (Hull and Netherlands S.S. Company). Zinc: Plates, 50 tons (H. Gardener & Company). Goole:—Iron: Pig, 150 tons, 3,756 bars, 91 castings. Steel: 728 bars, 105 plates, 2,289 sheets, 918 rails, 177 girders and joists. Grimsby:—Iron: 1,073 bars. Steel: 779 bars, 40 plates, 940 castings.

Tinplates.

Notwithstanding the rather gloomy aspect of trade conditions generally, a certain amount of business is still passing in the tinplate market, in which of late some inquiries for forward dates have been in circulation, and a fairly steady tone is in evidence. Prices for standard qualities of plates continue firm. Japan is reported to have bought oil sizes, and Norway and Sweden have been in the market for 28 by 20's. In a few cases works are now disposed to book forward at lower rates, but generally makers are holding out for at least 30s. per basis box, as against 28s., the current quotation. A quieter tone is evidenced in terne plates, which are quoted at round 27s. 6d. for usual specifications, net f.o.t. The lack of fuel supplies is beginning to be seriously felt by the few works that are still running, and more mills are ceasing operations. There are now only 70 mills operating in the tinplate industry as compared with 394 a year ago. Current prices are :—Cokes, 20 by 14, 28s. 6d. to 31s. 6d.; do. quarters, 30s. to 31s.; cokes, 20 by 10, 38s. to 40s.; do. 28 by 20, 54s. to 63s.; ternes, 28 by 20, 55s.

Scrap.

In all branches of the scrap metal trade, both ferrous and non-ferrous, business continues in a stagnant condition, due largely to current labour troubles, and partly no doubt to the general lack of demand for iron and steel products at home and abroad. Dealers consequently are reluctant to add to their already accumulated stocks, while buying on the part of consumers is absolutely at a standstill. As instancing the general tendency of the trade at the moment, it is reported from Lancashire, one of the principal centres of the foundry industry, that consumers of wrought scrap are offering as low as £3 per ton, a price at which it must be profitable even to stock until a revival of business arrives, while steel scrap, said to be bought recently at £2 per ton, must be worth at least twice that figure, granting even that the price of hematite is reduced much below current quotations. In South Wales the scrap market is still depressed, and supplies are generally on offer. Bundled steel scrap and shearings are quoted 50s. to 60s.; steel turnings, 45s. to 65s.; mixed wrought-iron and steel scrap, 26s. to 70s.; heavy cast-iron scrap, £3 15s.; and good machinery scrap, £5 to £6.

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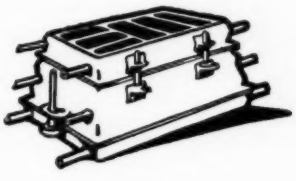

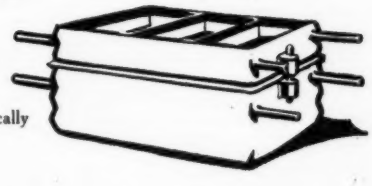

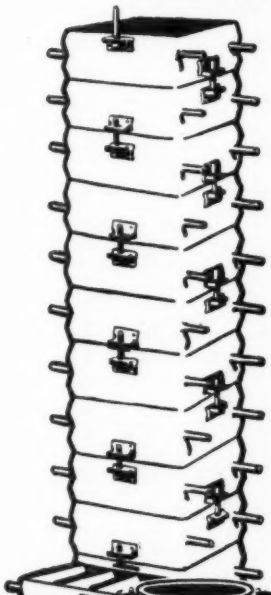

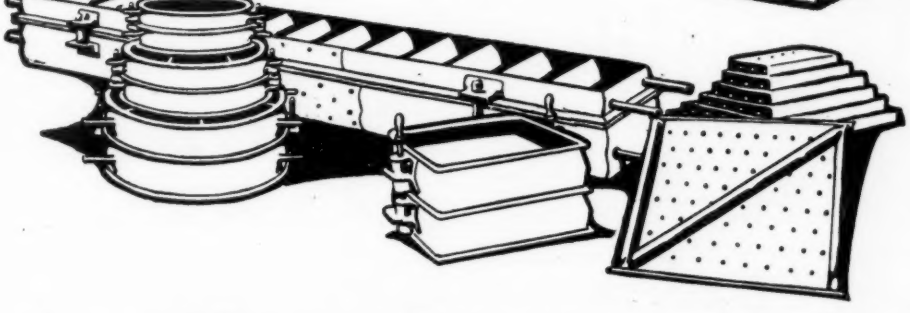

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Metals.

Copper.—The week's markets for standard copper opened with a quieter tendency, the continued absence of buying on home consumer's account having a marked effect upon the turnover, sales being limited to 250 tons. Near dates were, however, firmly held, with cash on balance fractionally higher, but refined descriptions were weaker, electrolytic being 15s. lower at £71 to £73, while bars on the same levels were 20s. down. Messrs. Henry Bath & Son, in their fortnightly report, state :—" Home trade is paralysed by the coal strike, but inquiries for bottoms and sheets, both copper and yellow metal, are dribbling in from the East. The leading American producers continue to quote 12¾ cents to 13 cents for near delivery, but outside holders are prepared to shade these prices. In the meantime a moderate business is taking place, mostly for domestic requirements, although there is some demand for export, principally for Germany." That country, it may be added, has been a steady buyer of American copper for some time past, and it is estimated that her daily takings have ranged between 500,000 lbs. and 1,000,000 lbs., with transactions mostly for cash, except in a few isolated instances, when barter has been the basis. During January exports of copper from the United States to Germany were far ahead of any other country, totalling at 18,801,672 lbs. The strides made by Germany in regaining its position as one of the best customers of American copper producers is shown by exports of 51,128,048 lbs. made to that country in seven months to the end of January compared with 11,512,700 lbs. in the seven months ending January, 1920. Latterly the British coal strike has held up foreign buying of copper, and this, coupled with a decrease in the domestic demand, caused a slight set-back in values, and at the close electrolytic spot and May were offered at 12¾ c. per lb. Closing prices :—Cash : Wednesday, £70; Thursday, £70 10s.; Friday, £70 7s. 6d.; Monday, £70 10s.; Tuesday, £71 5s. Three Months : Wednesday, £70 2s. 6d.; Thursday, £70 5s.; Friday, £69 17s. 6d.; Monday, £69 15s.; Tuesday, £69 15s.

Tin.—Cables from the East reporting sales of fine tin at £179 c.i.f. had little stimulating effect upon Monday's opening market on this side, values showing an easier tendency, with cash quoted 20s lower than the previous closing prices. Business on the whole was quiet and uneventful, with an absence of selling pressure, forward metal developing further weakness towards the close; June dates were done at £172 to £172 5s.; July, £173 10s. to £172 5s.; English ingots closing 30s. lower at £166 10s. to £167 10s. The weekly return of stocks of tin show a decrease of 134 tons at 3,659, Liverpool an increase of 362 tons at 2,598, and Swansea unchanged at 66 tons. Closing prices :—Cash : Wednesday, £172; Thursday, £172; Friday, £171 10s.; Monday, £169 10s.; Tuesday, £168. Three Months : Wednesday, £174 10s.; Thursday, £174 15s.; Friday, £174,; Monday, £171 10s.; Tuesday, £170 10s.

Spelter.—Messrs. Henry Bath & Son, Ltd., reporting on this metal, state :—A firm tone has been maintained in the spelter market, the chief fluctuations taking place in the near position, while forward metal has ruled extremely steady round about £27 per ton. The demand from the trade continues meagre, but supplies are not unwieldy, and the market meets with continued support. Ordinary brands, prompt :—Closing prices : Wednesday, £26; Thursday, £26 5s.; Friday, £26; Monday, £26; Tuesday, £25 7s. 6d.

Lead.—Business in this week's market has taken a quieter turn, and with holders showing little disposition to sell at current rates, transactions in this metal have been negligible in volume. There has, however, been a good covering demand for June lead, which is at a premium over other months. The position of the outside market in the States is firmer, and carload lots en route are reported sold at 4.57½ c. delivered. There is no change, however, in the official price of 4.25 c., and it is stated that the principal interest is taking new business on that basis. The stocks here are rather light, and only the slackness of demand prevents something of a temporary stringency.

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BARGAINS in Metal Melting Furnaces, 2, Morgan Coke-fired Tilters, 5/600 lbs. cap.; cost £300 each, accept £110 each. One M.R.V., 440 lbs. cap., Coke-fired Tilter, £100. 2 Monometer Oil-fired Furnaces (Tilters), 800 lbs. cap., as new, £125 each. One 300 lbs. cap. Oil-fired Monometer Tilter; what offers? All above Furnaces are in as good a condition as new for work.—The Furnace Exchange, Croft Street Engineering Works, Preston, Lancs.

HALL'S Invincible Sand Mixer, capacity 1 ton per hour, 18 in. dia., equal to new, suitable for mixing and preparing all kinds of foundry sands at the lowest cost per ton.—Apply, C. E V. Hall, 26, Paradise Square, Sheffield.

FOR SALE.—One Anglo-American Dead-blow, Four-headed Power Hammer, second-hand, for light forgings, 2½-cwt. drop heads, in good working condition; best offers.—Apply to Wilson Bros., Bobbin Company, Garston, Liverpool.

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5-ton Overhead Foundry Crane, 30 ft. span.
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20, 30, 40 and 50-h.p. Electric Motors, 460 Vo. D.C.
Blowers, Fans, Engines, etc. Send your enquiries, Harry H. Gardam & Company, Limited, Staines. 'Phone 98

Every description of Steel Stamps made on the premises by ex-service men. 33 years' experience. Personal producer.
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ENGINEERS, FOUNDERS, SCIENTIFIC APPARATUS MAKERS,
VICTORIA WORKS, OSWESTRY, SHROPSHIRE,
Telephone : 118 OSWESTRY.
Are Fully Equipped for :—ACCURATE PATTERN MAKING.
Quotations :—Promptly from Drawings or Old Castings.
Also Castings in Grey Iron and Brass.
LARGE OR SMALL WORK.
EFFICIENCY IN MOULDING SPECIALLY STUDIED.

MACNAB & Co.

TABOR MOULDING MACHINES (TABOR PATENTS)

For Every Class of Work.

Pit Type and Portable Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Machines; Power Squeezing and Jar Squeezing Machines; Shockless Jarring Machines, etc., etc.

SPECIAL FEATURES AND ADVANTAGES:

Accurate Definite Draw with Permanent Accurate Alignment.

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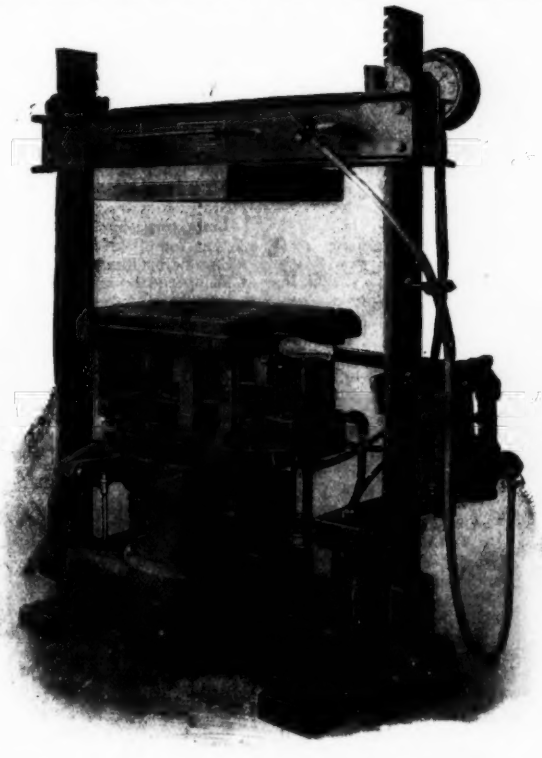

Uniformity in size of Castings produced.

All Moulds squeezed alike to whatever Pressure Required.

Minimum Percentage of Wasters.

The above illustrates the TABOR POWER SQUEEZING "SPLIT PATTERN" MOULDING MACHINE, specially suitable for all small patterns which can be split in halves or for flat back work.

Capacities and Dimensions furnished upon application:

56/8, Eagle Street, Southampton Row, London, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	71	5	0
Three months	69	15	0
Electrolytic	71	0	0
Tough	71	0	0
Best selected	71	0	0
Sheets	116	0	0
India	116	0	0
Wire bars	72	0	0
Do. June	72	0	0
Do. July	72	0	0
Ingot bars	72	0	0
H.C. wire rods	80	0	0
Off. aver. cash, Apr.	69	8	11⅞
Do. 3 mths., Apr.	69	9	2⅝
Do. Settlement Apr.	69	8	6½
Do. Electro, Apr.	72	16	2⅞
Do. B.S., Apr.	71	6	8
Aver. spot, copper, Apr.	69	7	10¼
Do. Electro, Apr.	73	16	8
Solid drawn tubes		15½d.	
Brazed tubes		15½d.	
Wire		12d.	
Yellow metal rods		8½d.	
Do. 4x4 Squares		10½d.	
Do. 4x3 Sheets		10½d	

BRASS.

Solid drawn tubes	13½d.
Brazed tubes	16½d
Rods	12¼d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	11¼d.

TIN.

	£	s.	d.
Standard cash	168	0	0
Three Months	170	10	0
English	166	0	0
Bars	168	0	0
Chinese	163	0	0
Straits	176	15	0
Australian	176	15	0
Eastern	179	0	0
Banca	184	15	0
Off. aver., cash, Apr.	164	0	11⅞
Do. 3 mths., Apr.	166	19	4½
Do. Sttlment., Apr.	164	0	0
Aver. spot, Apr.	163	19	3½

SPELTER.

	£	s.	d.
Ordinary	25	7	6
Remelted	21	10	0
Hard	16	10	0
Electro 99.9	34	0	0
English	29	10	0
India	19	10	0
Prime Western	27	0	0
Zinc dust	50	0	0
Zinc ashes	6	0	0
Off. aver., Apr.	26	1	5⅞
Aver., spot, Apr.	25	10	7

LEAD.

	£	s.	d.
Soft foreign ppt	21	17	6
English	23	2	6
Off. average, Apr.	20	16	10½
Average spot, Apr.	20	11	9½

ZINC SHEETS.

	£	s.	d.
Zinc sheets, spot	36	0	0
Do. V.M. ex. whf	36	0	0
Do. ppt., f.o.b., N.Y.		—	
Dutch	35	0	0
Boiler plates	32	10	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d.
English regulus	37	0	0
Special brands	42	0	0
Chinese	24	10	0
Crude	18	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	11	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£17 5 0
75%	£24 10 0
Ferro-vanadium—	
35/40%	24/6 lb. va.
Ferro-molybdenum—	
70/80%	10/- lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/6 lb.
Ferro-phosphorus, 20/23%	£32
Ferro-tungsten—	
80/85%, carbon free	1/10 lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
4/6% car.	£37 0
6/8% car.	£36
8/10% car.	£35 10
Ferro-chrome—	
Max. 2% car.	£84
Max. 1% car.	£100
Max. 0.75% car.	£115
65/75%, carbonless	2/9 lb.
Nickel—99·8%, cubes or pellets	£195
Cobalt metal—97%	18/0 lb.
Aluminium—98/99%	£150
Metallic Chromium—	
98/99%	6/6 lb.
Ferro-manganese—	
76/80%, loose	£22
76/80%, packed	£23
76/80%, export	£19
Metallic manganese—	
98/99%, carbonless	3/- lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	3	0
Finished bars, 18% tungsten	3	9
Scrap pieces		5d.
Turnings and swarf		3d.

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing 4s. cwt
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 5d.
Turnings and swarf 3d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—£ s. d.			
Heavy Steel	3	0	0
Bundled steel & shearings	2	15	0
Mixed iron & steel	1 0 0	4	0
Heavy cast iron	3	15	0
Good machinery for foundries	5	10	0
Cleveland—			
Heavy steel	2	10	0
Steel turnings	2	7	6
Cast-iron borings	2	7	6
Heavy wrought iron piling	3	10	0
Bundling scrap	4	5	0
Cast-iron scrap	5	10	0
Lancashire—			
Cast iron scrap	6	0	0
Heavy wrought	3	10	0
Steel turnings	1	10	0
London—			
Copper (clean)	49	0	0
Brass (clean)	28	0	0
Lead (less usual draft)	16	10	0
Tea lead	14	10	0
Zinc	13	0	0
New aluminium cuttings	75	0	0
Braziery copper	39	0	0
Gun metal	45	0	0
Hollow pewter	130	0	0
Shaped black pewter	75	0	0

PIG-IRON.

N.-E. Coast—	
Foundry No. 1	125/-
Foundry No. 3	120/-
Forge No. 4	117/6
Mottled	117/6
Hematite No. 1	162/6
Hematite M/Nos.	160/-
Midlands—	
Staffs. common	145/-
,, part-mine forge	160/-
,, ,, foundry	170/-
,, Cold blast	340/-
,, basic	140/-
Northants forge	140/-
,, foundry No. 3	147/6
,, basic	140/-
Derbyshire forge	150/-
,, foundry No. 3	160/-
,, basic	150/-
Scotland—	
Foundry No. 1	170/-
,, No. 3	165/-
Hematite M/Nos.	180/-
Sheffield (d/d district)—	
Derby forge	155/-
,, foundry No. 3	160/-
,, basic	155/-
Lincs. forge	160/-
,, foundry No. 3	170/-
,, basic	162/6
E.C. hematite	173/-
W.C. hematite	196/-
All d/d in the district.	
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, foundry No. 3	170/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	172/6
,, foundry No. 3	177/6
Summerlee foundry	193/-
Glengarnock foundry	193/-
Gartsherrie foundry	193/-
Monkland foundry	193/-

FINISHED IRON & STEEL.

	£	s.	d.
Iron—			
Bars (cro'n)	19	0	0
Angles	19	10	0
Tees to 3 united ins.	20	0	0
Nut and bolt	19	0	0
Hoops	23	0	0
Marked bars (Staffs.)	27	10	0
Gas strip	22	0	0
Bolts and nuts, ¾ in. × 4 in.	38	0	0
Steel—			
Ship plates	19	0	0
Boiler plates	25	0	0
Chequer plates	20	0	0
Angles	17	10	0
Tees	18	10	0
Channels	18	0	0
Joists	17	10	0
Rounds, ¾ in.–3-in.	14	10	0
Rounds, 3 in.–5½ in.	13	10	0
Flats, 5 in.–8 in.	15	0	0
Flats over 8 in.	13	10	0
Rails, heavy	15	0	0
Fishplates	20	0	0
Hoops	17	10	0
Black sheets, 24 g.	20	10	0
Galv. cor. sheets, 24 g.	22	0	0
Galv. fencing wire, 8 g. plain	26	0	0
Rivets, ¾ in. dia	27	0	0
Billets, soft	13	0	0
Billets, hard	14	0	0
Sheet and tin bars	13	0	0

PHOSPHOR BRONZE.

Rolled.	Per lb. s.	d.
⅛ in. to 1 in. wide	1	9¾
1 in. to 1½ in. wide	1	9½
1½ in. to 2 in. wide	1	7¾

Strips.	s.	d.
2 in. to 6 in. to 26 S.W.G.	1	7½
6 in. to 12 in. to 26 S.W.G.	1	7½

Sheets.	s.	d.
12 in. to 18 in. to 24 S.W.G.	1	7½
18 in. to 24 in. to 24 S.W.G.	1	8¼
24 in. to 30 in. to 20 S.W.G.	1	9½
30 in. to 36 in. to 16 S.W.G.	1	9¾
36 in. to 42 in. to 16 S.W.G.	1	10¾

Extras.

For Gauge: Any width up to 36 in. wide, ½d. per lb. per thinner gauge.

Drawn Rods.	s.	d.
¼ in. to ½ in. dia. in random lengths; 5/16 in. to 1½ in. dia. in random lengths	1	8
Over 1½ in. to 1¾ in.	1	8
Tubes—basis price	1	9¾

Delivery 2 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/1 to 1/7
Rolled—	
To 9 in. wide	1/8½ to 2/2½
To 12 in. wide	1/9 to 2/3
To 15 in. wide	1/10 to 2/4
To 18 in. wide	1/11 to 2/5
To 21 in. wide	2/- to 2/6
To 24 in. wide	2/1 to 2/7
Ingots for spoons and forks	1/1 to 1/7
Ingots rolled to spoon size	1/4 to 1/10
Wire round—	
3/0 to 10. G.	1/11 to 2/6

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	26.26
No. 2 foundry Valley	24.50
No. 2 foundry, Birm.	23.00
Basic	24.96
Bessemer	26.96
Malleable	26.96
Grey forge	25.46
Ferro-manganese 80 % delievred	90.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	37.00
O.-h. billets	37.00
O.-h. sheet bars	39.00
Wire rods	48.00
	Cents.
Iron bars, Phila.	2.35
Steel bars	2.10
Tank plates	2.20
Beams, etc.	2.20
Skelp, grooved steel	2.20
Skelp, sheared steel	2.20
Steel hoops	2.75
Sheets, black, No. 28	4.00
Sheets, galv., No. 28	5.00
Sheets, blue an'l'd, 9&10	3.10
Wire nails	3.25
Plain wire	3.00
Barbed wire, galv.	4.00
Tinplate, 100-lb. box	$6.25

COKE.

Welsh foundry	67/6
,, furnace	55/-
Durham & North. foundry	70/-
,, furnace	42/6
Other Districts, foundry	77/9
,, furnace	45/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price £35 to £37

Rolled Ordinary— Assortment ..	£	s.	d.
Nail Rods— Square, round and flats ..	23 to 24	0	0
Keg Steel / Faggot Steel	about £40	Prices nominal.	

Blooms—
Single welded .. £16 to £18

Billets—
Single and double welded .. £18 to £23

Pig-Iron—
Grey, white or mottled .. £13 to £14

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas ..	−15%	−20%
Water ..	− 5%	−11¼%
Steam ..	+ 6¼%	− 1¼%

TINPLATES.

I.C. Cokes,	20×14, box	28/6
„	28×20, „	54/-
„	20×10, „	38/-
„	18¾×14, „	30/6
I.X.	„	73/-
I.X.X.	„	103-
F.C.B.Y.	21×13⅝ „	50/6
C.V.B.G.	16½×15, „	50/-
I.C.W.	20×14, „	21/-
„	28×20, „	42/-
„	20×10, „	28/6
„	18¾×14, „	18/3
Terneplates,	28×20, „	55/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Apr.27	70	0	0	dec.	5/-
„ 28	70	10	0	inc.	10/-
„ 29	70	7	6	dec.	2/6
May 2	70	10	0	inc.	2/6
„ 3	71	5	0	„	15/-

Electrolytic Copper (Cash).

Apr.27	72	0	0	No change	
„ 28	72	0	0	No change	
„ 29	72	0	0	No change	
May 2	71	0	0	dec.	20/-
„ 3	72	0	0	inc.	20/-

Standard Tin (cash).

Apr.27	172	0	0	dec.	35/-
„ 28	172	0	0	No change	
„ 29	171	10	0	dec.	10/-
May 2	169	10	0	dec.	40/-
„ 3	168	0	0	dec.	30/-

Tin (English Ingots)

Apr.27	168	0	0	dec.	40/-
Apr.28	168	0	0	No change	
„ 29	167	10	0	dec.	10/-
May 2	166	0	0	dec.	30/-
„ 3	164	0	0	dec.	40/-

Zinc Sheets (spot).

Apr.27	36	0	0	No change	
„ 28	36	0	0	No change	
„ 29	36	0	0	No change	
May 2	36	0	0	No change	
„ 3	36	0	0	No change	

Spelter (ordinary).

Apr.27	26	0	0	dec.	5/-
„ 28	26	5	0	inc.	5/-
„ 29	26	0	0	dec.	5/-
May 2	26	0	0	No change	
„ 3	25	7	6	dec.	12/6

Lead (English).

Apr.27	22	5	0	No change	
„ 28	22	10	0	inc.	5/-
„ 29	22	15	0	„	5/-
May 2	22	15	0	No change	
„ 3	23	2	6	inc.	7/6

SHROPSHIRE IRON Co., Ltd.

Works :—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams :—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone :—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals :—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

ROBERT HEATH & LOW MOOR, LIMITED,
Stoke-on-Trent.

B.B.H. IRON.
At works.
BARS, ANGLES, TEES and PLATES.

R.H. ♔ IRON.
Delivered F.O.B. Liverpool.
BARS, ANGLES, TEES and PLATES.

HOOPS delivered F.O.B. Liverpool.

IRON
R.D. ♔

RAVENSDALE (Best)

MILD STEEL (up to 2in. wide)
Marked
"HEATH'S SOFT STEEL."

Prices on Application.

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5, EAST INDIA AVENUE, LONDON, E.C.3.

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Telegrams : ALKALIZE, LONDON.
Telephone : 7860 AVENUE (3 lines.
Head Office:
5, EAST INDIA AVENUE, London, E.C.

REGISTERED TRADE MARK
CUMBRIA

PIG IRON.

Scotch, Middlesbro,' Hematite, Basic, Specials, &c., &c.

TIN — SPELTER — CHROME
COPPER — ANTIMONY—MANGANESE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE.
MIDDLESBROUGH.

93, HOPE STREET,
GLASGOW.

XUM

SITUATIONS VACANT AND WANTED.

ADVERTISER, Englishman, 37 years of age, engineering training, expert in quantity production of iron and steel castings for motor transport and general engineering, and in steel-making for foundries, forges, and rolling mills (best British and Continental practice), open to engagement as Foundries' or Steelworks' Manager, or would be responsible to enterprising firm for the design, equipment, and operation of new works or the development of old works in this country to meet foreign competition; highest references.—Box 742, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN (Iron) desires re-engagement; thorough practical knowledge of all branches of the trade; up to date in machine moulding, and expert in mixings.—Box 740, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERNMAKER (Improver) seeks Situation in a small Foundry; Midlands preferred.—Box 738, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY MANAGER desires change, wide modern experience, Cast and Malleable Irons Crucible Steel (mild), Gunmetal, Aluminium, etc.; expert experience of modern moulding machines (all types) and organisation; can get results; able to introduce new clients, or would consider representing up-to-date firm in London area; age 41; energetic, industrious, of good address, and reliable.—Box No. 734, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATENTS.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE owners of British Patent No. 11839/10, entitled "Process for the Cementation of Articles of Iron, Steel and Alloys of Steel," desire to make working arrangements with a firm likely to be interested, or to sell the Patent outright. A copy of the specification and full particulars may be obtained from HERTFORD RECORD COMPANY, LIMITED, of Lindsey House, 59, Lincoln's Inn Fields, London, W.C.2.

MISCELLANEOUS.

ORDERS WANTED for small Machine-made Castings in Brass, Gunmetal, Phosphor, or Manganese Bronze. Also Castings any size up to one ton in weight. Prompt delivery.—JAMES G. CROWTHER, Paradise Street Brass Foundry, Sheffield.

CASTINGS (IRON) ORDERS WANTED for any weight and size (Yorkshire District). Machines if necessary.—Address, Box 728, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WE Specialise in Aluminium Castings, die and sand. Enquiries solicited. Prompt deliveries. Also Castings in Brass, Gunmetal and Phosphor or Manganese Bronze.—H PERKS & Co., 90, Seymour Place, W.1.

ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to 5 cwt. Complete Machines built throughout to specification, singly or in quantity. Jig and Tool Work a speciality.—C. S. PEATFIELD, LIMITED, Market Rasen, Lincs.

PATTERNS and CASTINGS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with VIDEX PATTERN WORKS AND FOUNDRY, Huntsworth Mews, Upper Baker Street, London, N.W.1. (Telephone, Paddington 364).

FOR SALE, cheap, Foundry Pig Iron, all sections, F.B. Steel Rails, with all accessories; Joists, Channels, Angles, Sheets and Plates, all thicknesses; plumbago.—Ascog, Golder's Green, London. Telephone; Hampstead, 1806.

WE Specialise in FANS and FAN WORK for Foundries. H.P. Fans and Blowers for Smiths' Hearths, Cupolas, Oil and Gas-fired Furnaces, Dust Extraction Fans for Fettling Shop and Sand Blast, Ventilating Fans for Fumes, etc. Worm-geared Pulley Blocks, 10 cwt. to 10 tons.—PROGRESSIVE ENGINEERING COMPANY, LIMITED, Leicester.

MISCELLANEOUS,—*Contd.*

GOVERNMENT Surplus, 3,300 Bastard Files, 8 to 14 in., 132 dozen half-round 6 in., 120 round 10 in., 3 tons 18 and 34 G Bright Wire in coils, 5,000 ft. new Balata Belting, 100 reams Oakey's Emery Cloth and other goods; bargain.—Write for particulars, JOHN TAYLOR & SONS (1920), LIMITED, Norland Road, Notting Hill, London.

FIREBRICKS.—Best Stourbridge Firebricks and Fireclay, at exceptionally low prices, delivered by truck or van.—YOUNG & SON, Rosher's Wharf, Kingsland Road, E.8.

SWEDISH DEAD SOFT CHARCOAL STEEL, about

2 tons	5/16 in. round	
3 ,,	13/16 in. ,,	Price £21
3 ,,	⅜ in. ,,	
3½ ,,	7/16 in. ,,	or offer.
4 ,,	½ in. ,,	
8 ,,	⅝ in. ,,	Delivery ex stock.
8 ,,	15/16 in. ,,	

IVAR FORSSBERG, 110, Cannon Street, E.C.4.

SMALL FOUNDRY for SALE; in good condition, suitable for motor work; Hull district.—Box 736, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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FOR SALE.

Four NEW THOMPSON DISHENDED LANCASHIRE BOILERS, 30 ft. by 8 ft. 6 in., for 150 lbs. pressure.

Five LANCASHIRE BOILERS, 30 ft. by 7 ft. 6 in., now insured at 160 lbs. pressure.

Five DAVEY PAXMAN ECONOMIC BOILERS, each 14 ft. by 8 ft., for 160 lbs. working pressure, and two ditto 180 lbs. working pressure.

Twenty-four MARINE TYPE SELF CONTAINED WATER TUBE BOILERS, by Messrs. Babcock & Wilcox, Limited, varying in heating surface for a working steam pressure of 270 lbs. per sq. in.

One LANCASHIRE BOILER, 30 ft. by 8 ft. dia., re-insure 120 lbs. pressure.

One LANCASHIRE BOILER, 30 ft. by 7 ft 6 in. dia., re-insure 140 lbs. pressure.

Three MARINE WATER TUBE BOILERS, by Yarrow, each 4,000 sq. ft. htg. surface, re-insure 200 lbs. pressure.

Two MARINE BOILERS, 10 ft. 4 in. long by 12 ft. 2 in. dia., re-insure 150 lbs. pressure

One SPENCER HOPWOOD VERTICAL BOILER, 10 ft. 8 in. by 4 ft. 9 in. dia., re-insure 100 lbs. pressure.

MARINE TWO FURNACE BOILER, 9 ft. 6 in. dia by 10 ft. long, re-insure 100 lbs. pressure.

One HORNSBY WASTE HEATWATER TUBE BOILER, about 40 h.p., re-insure 160 lbs. pressure.

One LOCO. TYPE BOILER, barrel 12 ft. long by 4 ft. 8 in. dia., re-insure 150 lbs. pressure

Large quantity of Cast-Iron Flanged Pipes, 4 in. to 12 in. dia., principally in 9-ft. lengths.

Several Hundreds of TANKS, rectangular and circular, 10 gallons capacity upwards, at Sheffield and elsewhere.

Several Unused SECTIONAL STEEL CISTERNS, 8 ft. by 8 ft. by 4 ft. deep, capacity about 1,600 gallons each.

40/50 BUOYS, each 4 ft. long by 2 ft. 9 in. dia., by about ¼ in. thick.

About 4,300 ft. run of Galvanised Piping 2 in dia.

About 1,300 ft. run of New Cast-Iron Piping 6 in. dia.

Three steel Stanchions, each 24 ft. 9 in. high by 19 in. by 12 in. section

Large number of GALVANISED STEEL WIRE ROPES, each 300 ft. long by 1¼ in. circumference, thimble at one end.

SECTIONAL TELESCOPIC LADDER, six 10-ft. wood sections, on 4-wheel carriage.

CATALOGUE of STOCK MACHINERY, 5-600 Lots Free on Application. Inspection Invited.

THOS. W. WARD, Albion Works, SHEFFIELD
Telegrams: "Forward, Sheffield."
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For continuation of Small Advertisements see page 418.